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Urban Meadow Learning Resource

National Museum Cardiff

RELEVANT TO
THE NATIONAL
LITERACY AND
NUMERACY
FRAMEWORK



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BACKGROUND INFORMATION FOR TEACHERS

The Urban Meadow

We have created an Urban Meadow on the Museum grounds to attract bees and other pollinators into the city centre. We hope that our Meadow will inspire others to make our towns and cities more welcoming to wildlife of all kinds.

We are particularly concerned about bees as many bee species are declining in the UK. Bees like to feed on certain flowers such as clover and poppies which now grow here during the summer months. The Museum has also installed bee hives on the roof. You can't see the hives but the honey bees are visiting this Meadow and other green spaces in the city.

Booking a visit

Learning Office – for bookings and general enquiries

Tel: **029 2057 3240**

Email: **learning@museumwales.ac.uk**

All groups must book in advance, whether visiting independently or on a museum-led visit. The information in this pack enables you to run your own teacher-led session. Gallery talks and workshops are available for all progression steps on selected dates each term. You may wish to book a museum-led session to complement your visit. See our website for more details:

www.museumwales.ac.uk/learning/cardiff/

Using this pack

This pack is designed to support Foundation Phase and Progression Steps 2 and 3 teachers and educators in preparing for a self-led museum visit, but can also be used to support learning inside and outside of the classroom. It includes information on the Urban Meadow and associated topics. There are lots of ideas and activities to explore before your visit, at the Museum, and back at school. There is a resources section at the back of the pack with worksheets and activities.

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Please consider the weather when planning a trip as the Urban Meadow is outdoors and open to the elements. It is a good idea to have a back-up plan which you can do inside the Museum in case of bad weather.

The Urban Meadow is a seasonal habitat and will therefore change throughout the year. If you want to see lots of wildlife such as flowers and insects then it is best to visit in the spring and summer.

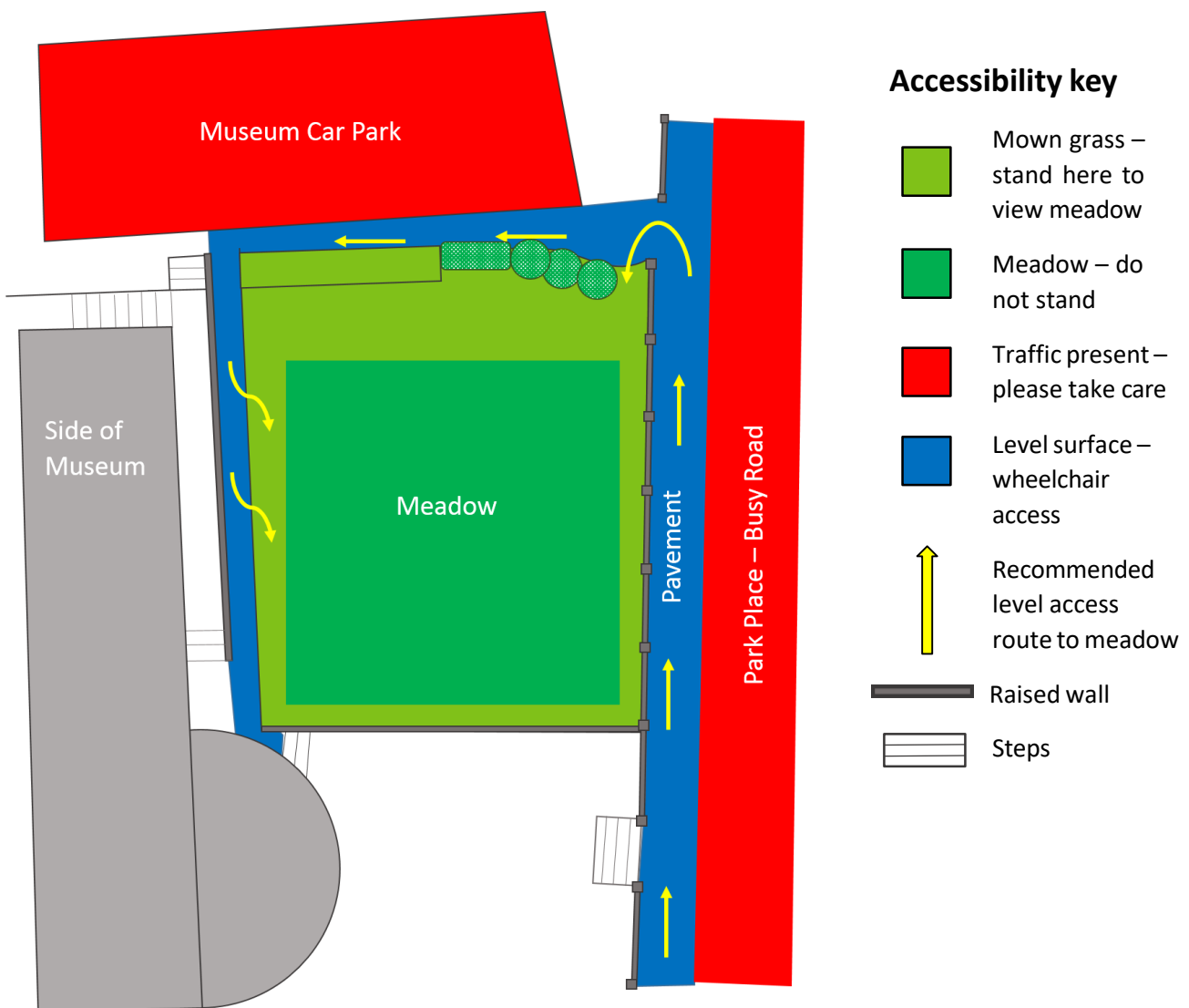
The area is directly accessible from the roadside.

The map below shows a level route for wheelchair access.

Don't stand on the Meadow!

The Urban Meadow is the dark green square area shown in the diagram below. We have mown the surrounding grass to provide an area where you can stand to look at and investigate the Meadow. We ask that you don't stand on the Meadow as it contains plants and animals that we want to protect.

One of our Museum scientists, Dr Mike Wilson, is a specialist in insects called leafhoppers and planthoppers. Dr Mike surveyed this area and found 15 times more hoppers living on the Meadow than on the mown grass! This shows that our Meadow is attracting lots of lovely minibeasts – and we don't want to squash them or the plants by walking on them! It is also a great sign that after only one year our Meadow has already increased the **biodiversity** of this small corner of the Museum site.



Curriculum links

The Curriculum Cymreig

- Learning about the relationship between the environment and the people of Wales and the effect this has on Welsh life today and in the past.
- Exploring current issues that affect the lives of people in Wales and the Welsh economy.
- Learning about sustainable development in Wales and the wider world.

Foundation Phase

The resource can be used to support a number of areas of the foundation phase curriculum, in particular:

- Personal and social development, well-being and cultural diversity – foster curiosity and develop positive attitudes to new experiences and learning.
- Language, literacy and communication – listen to and carry out instructions, extend vocabulary and write independently and collaboratively.
- Welsh language development – view a variety of visual stimuli.
- Knowledge and understanding of the world – explore, observe and investigate different environments, and ‘embracing science’.
- A visit also provides an opportunity to sequence events e.g. ‘a journey to the Museum’.

Progression Steps 2 and 3

- Science – a visit can help to develop skills and range in science
 - Interdependence of Organisms – explore environments and local plants and animals. Understand the interdependence of organisms in habitats and study the plants and animals found in two contrasting local environments. Also consider the environmental factors that affect what grows and lives in those two environments. Consider how humans affect the local environment.
 - Use apparatus and equipment correctly and safely. Make careful observations and accurate measurements.
- Art & Design – select and record from observations and experiences, and investigate the natural environment.
- Geography – explore our changing environment, from the past to the present. Pupils can follow directions and maps, and identify and describe natural features.
- ESDGC – the Meadow can provide stimuli for exploring the local and global implications of our actions on the natural environment and the choices and decisions we make in response.

Skills framework

The ideas within this pack will help develop enquiry, communication, and thinking skills **and support the literacy and numeracy framework**. Look out for the literacy and numeracy symbols:



Numeracy



Literacy

Below is a table which summarises the links between the LNF and the activities in each section of the pack:

Topic	Numeracy		Literacy	
	Strands	Elements	Elements	Aspects
Our Meadow	Using number skills	<ul style="list-style-type: none"> Use number facts and relationships Calculate using mental and written methods Estimate and check 	Oracy Developing and presenting information and ideas	<ul style="list-style-type: none"> Speaking Listening Collaboration and discussion
	Using measuring skills	<ul style="list-style-type: none"> Length Area 	Reading Responding to what has been read	<ul style="list-style-type: none"> Comprehension Respond and analysis
	Using data skills	<ul style="list-style-type: none"> Collect and record data Present and analyse data Interpret results 		
Creating Your Own Meadow	Using measuring skills	<ul style="list-style-type: none"> Length Temperature 	Oracy Developing and presenting information and ideas	<ul style="list-style-type: none"> Speaking Listening Collaboration and discussion
	Using data skills	<ul style="list-style-type: none"> Collect and record data Present and analyse data Interpret results 	Writing Organising ideas and information	<ul style="list-style-type: none"> Meaning, purposes, readers Structure and organisation
			Writing Writing accurately	<ul style="list-style-type: none"> Language
			Reading Responding to what has been read	<ul style="list-style-type: none"> Comprehension Respond and analysis

Topic	Numeracy		Literacy	
	Strands	Elements	Elements	Aspects
Urban Wildlife	Using measuring skills	<ul style="list-style-type: none"> Length Area Time 	Oracy Developing and presenting information and ideas	<ul style="list-style-type: none"> Speaking Listening Collaboration and discussion
	Using data skills	<ul style="list-style-type: none"> Collect and record data Present and analyse data Interpret results 	Writing Organising ideas and information	<ul style="list-style-type: none"> Meaning, purposes, readers Structure and organisation
Bees	Develop numerical reasoning	<ul style="list-style-type: none"> Identify processes and connections Represent and communicate Review 	Oracy Developing and presenting information and ideas	<ul style="list-style-type: none"> Speaking Listening Collaboration and discussion
	Using number skills	<ul style="list-style-type: none"> Use number facts and relationships Fractions, decimals, percentages and ratio Calculate using mental and written methods Estimate and check 	Writing Organising ideas and information	<ul style="list-style-type: none"> Meaning, purposes, readers Structure and organisation
	Using measuring skills	<ul style="list-style-type: none"> Weight/mass 	Writing Writing accurately	<ul style="list-style-type: none"> Language
	Using data skills	<ul style="list-style-type: none"> Collect and record data Present and analyse data Interpret results 	Reading Responding to what has been read	<ul style="list-style-type: none"> Comprehension Respond and analysis

Preparing for your visit

Be advised that some of the suggested activities will require specific equipment that you will need to bring with you to the Museum.

Why not write a class list of things you'd like to find out on your visit (you could use the 'KWL' chart in the resources section at the back of the pack).

Before your visit it would be helpful to talk to your class about habitats, the life cycle of a plant and the things animals and plants need to survive. The following words will help you in this discussion.

Some words you may use on your visit

We have highlighted these words where they are found in this resource pack

Habitat – A habitat is the place where a living thing (such as a plant or animal) lives. Every living thing has adapted to live in its specific habitat.

Diversity – Diversity simply refers to all of the different living things in a certain area. Sometimes you will see the word **biodiversity** used instead.

Pollination – Pollination is an important step in the life-cycle of flowering plants. During pollination, pollen from one flower must get to a different flower. Without this step, the plant could not make seeds (and therefore baby plants).

Pollinator – Some plants rely on animals to carry their pollen between flowers. A pollinator is any animal that carries pollen between flowers. Lots of pollinators are insects such as bees and butterflies, but other animals can be pollinators too, including some types of bat and hummingbird.

Insect – Insects are a group of animals which all have six legs and three parts to their bodies – a head, a thorax and an abdomen. There are more types of insect than of any other type of animal. Examples of insects include bees, butterflies, beetles and grasshoppers.

Pest – A pest is living thing which is considered a nuisance by humans. Examples include slugs and snails which eat garden plants and the Varroa mite which is a parasite in honey bee hives.

Weed – A weed is a plant growing in a place in which it is not wanted.

Pesticide – A pesticide is a poisonous chemical that some people use to kill pests that they don't want on their land. An example is slug pellets.

Herbicide – A herbicide is a pesticide that kills plants. It is also known as weedkiller.

Insecticide – An insecticide is a pesticide that kills insect pests. Pesticides can be harmful to insects which are not pests too.

Dormant – We say a plant is dormant when it is alive but not growing. Many plants remain dormant throughout the cold winter, waiting for the warmth and light of spring before they start to grow.

Urban – An urban area is anywhere where there is a town or city. Urban areas tend to have lots of people living in them and so have lots of man-made structures like buildings and roads.

Rural – A rural area is anywhere that isn't a town or a city. There tend to be fewer people living in rural areas and so fewer man-made structures.

Agricultural – An agricultural area is anywhere there is farmland. These areas may be used to grow crops or to rear animals.

Twitter

The Museum has several Twitter accounts which you can follow for information and updates:

Follow [@MuseumCdf_Learn](#) for all the news from our Learning department, including information on upcoming activities and events.

[@CardiffCurator](#) is run by museum scientists. They tweet about the work they are doing and post sneak-peak, behind the scenes photographs of our collections.

Stay tuned to both of these accounts for updates on our Urban Meadow.

Why not tweet about your meadow or wild space, or your visit to the Museum? We would love to hear how you got on! We would also love to see your photos, so if you're visiting the Museum's Meadow, planting flowers of your own, or doing one of the activities from this pack, please take lots of pictures and send them to us! Use the hashtag #urbanmeadow and tag the museum accounts mentioned above.

Spring Bulbs

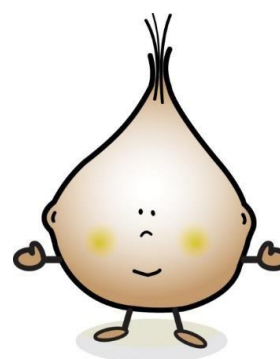
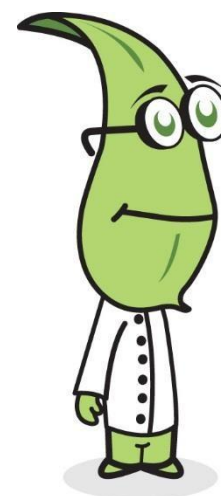
Make use of your outdoor classroom! Join Professor Plant and Baby Bulb, along with the 175 schools taking part in this exciting investigation. [Spring Bulbs for Schools](#) provides primary school pupils with the opportunity to adopt, study and record the development of spring bulbs as part of a spring watch network. Each pupil will receive bulbs and a garden pot to record growth and flowering times. Through collecting and comparing real data pupils discover how our changing climate is affecting our seasons and what this means for ourselves and the nature around us. Pupils take part in Professor Plant's Challenges to receive a super scientist certificate.

Any schools in Wales can take part as results are collected through the internet - or post if necessary. This is an on-going investigation - schools can take part year after year. Placements are available across Wales.

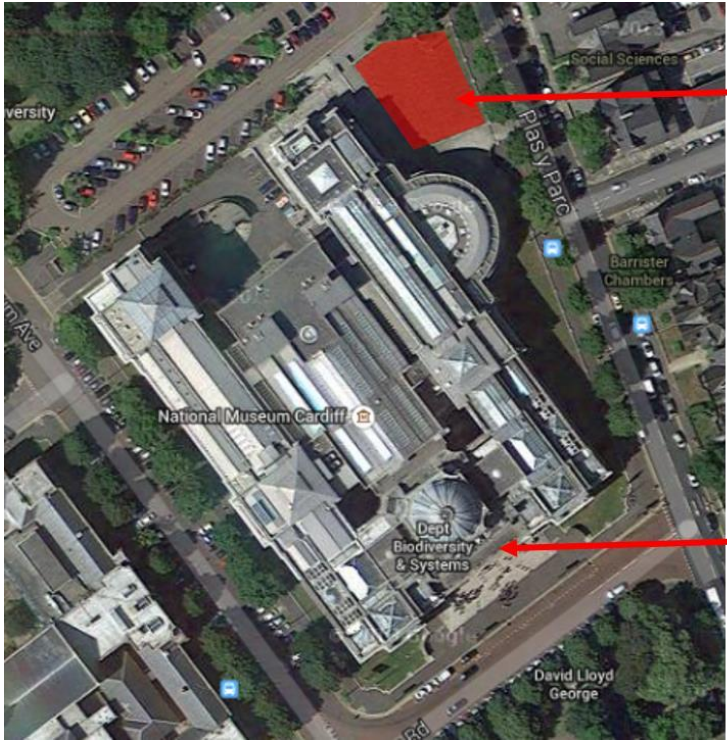
[Visit our website for more information.](#)

The project is also available to schools in Scotland and England. Please contact the [Edina Trust](#) for information on taking part.

For activity ideas, see Professor Plant's investigation ideas at the back of this pack.



OUR URBAN MEADOW



Urban Meadow

Museum entrance

Explore Together

- Sit around the edge of the Meadow
- Can you think of words to describe what you can see?
- How is the Meadow different to the other patches of grass nearby?
- Can you see any animals? What are they doing?
- Can you see flowers? What colours are they?

We created our Meadow in the centre of Cardiff to provide a natural haven for local wildlife within the urban landscape.

Wildflower meadows are usually made up of a combination of grasses and flowers. They provide excellent **habitat** for lots of animals, especially **pollinators** such as bees and butterflies. There are not as many wildflower meadows as there once were. Meadow plants grow well on poor quality soils, which means that often the grounds of schools and museums are ideal places for a meadow.



Cinnabar moth (*Tyria jacobaeae*) caterpillars on our Meadow

The site of our Meadow was previously short mown grass and offered little to attract wildlife. To create the Meadow we first allowed the grass to grow taller to see if other plant species would grow. We then removed small patches of turf and planted both seeds and plug plants of flowers and grasses. After planting, the area was allowed to grow naturally; we just made sure that plants like dandelions didn't take over. When growing a meadow you *can* start by removing the turf completely, but we chose not to, to avoid a muddy eyesore during the winter.



The site before we made the Meadow



The site with the Meadow in bloom

We cut the Meadow in early autumn, after most of the plants had set their seed for next year. We raked the grass clippings up which also helped to spread the seed around the Meadow. Next year we will cut the Meadow in the early autumn, but we may also cut earlier to encourage more flowers.



Mowing and raking the Meadow in the autumn



The Meadow after mowing

It is important to grow plants that are local to where you live. We have tried to use plants that you may find in a typical Welsh upland meadow.

We hope that the Meadow will inspire others to create green spaces of their own. Our dream is that this will lead to the creation of a patchwork of green spaces in and around Cardiff which would allow the local wildlife to prosper.



A meadow at the National Botanic Gardens of Wales in Carmarthen

Activity Ideas

How big is our Meadow? How could you measure it without a tape measure? E.g. paces, lying down end to end, etc. **N**

Once you know how long and wide the Meadow is, can you work out its area? **N**

Count how many different types of plants/flowers you can see on the Meadow. Do you recognise any of them? **N**

How many flowers do you think there are on the Meadow? First have a guess. Then count how many there are in a small area (e.g. 1m²) and use the total area of the Meadow to get an estimate. **N**

Can you see any animals on the Meadow? Look closely for any little minibeasts hiding among the plants. Make a list of what you see, or draw your favourite.

Stay very quiet and listen carefully. What sounds can you hear? Can you hear birds singing? Or the buzzing of a bumblebee?

When you get back to school you could draw/paint a meadow of your own. Remember, there should be lots of different flowers, so make it very colourful! Will there be animals in your meadow? A buzzy bee perhaps? Or caterpillars chomping on leaves?

Have a go at the 'Urban Meadow word-search' at the back of this pack. **L**

Read Peter Brown's 'The Curious Garden' together as a class. It is a really nice story about a little boy who transforms a dreary city by planting lots of plants. **L**

Create a class wildlife-friendly city. Use recycled materials (e.g. cardboard boxes, toilet roll tubes, paper bags) to make buildings. Think about how your city will be a good place for animals to live. Will it have lots of flowers for bees?

CREATING YOUR OWN MEADOW OR GREEN SPACE

Anybody can create a natural space, whether in a big garden or a simple window box. Spaces such as allotments and community gardens are also great for attracting wildlife.

Why not have a go yourself?

There are lots of ways you can attract wildlife to your school or garden. You could:

- Create **log piles** which make great homes for lots of minibeasts such as insects, spiders, centipedes and woodlice.
- Install a **bird feeder** or **bird bath** – This should encourage a range of species including tits, finches and robins.
- Install a **bee hotel** for solitary bees to sleep in (look at the back of this pack for instructions on how to 'Make your own bee hotel').
- Take inspiration from our Meadow and **plant flowers** to attract pollinators such as bees and butterflies. Why not use our 'Easy-peasy step-by-step guide to creating a mini-meadow' at the back of this pack?

If you want to attract pollinators you need to choose plants that these insects like. The plants should flower from early spring to late autumn, which is when the pollinators are most active. For some ideas of plants you could grow, look at our 'Twelve pollinator-friendly plants' worksheet at the back of this pack.

If you want more ideas, The British Beekeepers Association have compiled a [huge list of pollinator-friendly plants](#). The Royal Horticultural Society have also made a list of plants called 'Perfect For Pollinators'. Download it for free [here](#).

Try not to use pesticides or herbicides on your meadow or in your garden as many are toxic to pollinators.

Pesticides and **herbicides** are poisonous chemicals that some gardeners and farmers use to kill plants and animals that they don't want on their land. We call these plants and animals **weeds** and **pests**. Unfortunately these chemicals can kill meadow plants and the pollinators that visit the meadow. They can also kill other animals in the food chain, for example birds, frogs and hedgehogs that eat slugs that have been poisoned by slug pellets.


If you do not live in a town or city you can still do your bit to help local wildlife. Much of the British countryside is **agricultural** (farm) land. Some farms are made up of huge fields of a single crop. Planting more pollinator friendly plants in your garden or school means that rural areas will be more welcoming to wildlife too.





A Common Blue butterfly (*Polyommatus icarus*) visiting our Meadow

Activity Ideas

Why not have a go at creating a natural space of your own? Look at the 'Twelve pollinator-friendly plants' list in the resources at the back of this pack for ideas on what to grow. You could also follow our 'Easy-peasy step-by-step guide to creating a mini-meadow'.


Everyone in the class could adopt a plant and be responsible for looking after it. Can you remember what a plant needs to survive? Do plants eat food like animals do? What do they need instead? Discuss these topics as a class or in small groups. 


Who can grow the biggest plant? Or the plant with the most flowers? Use a tape measure to record growth each week. 


What factors influence the growth of a plant? Design an experiment to test how temperature, water and sunlight affect plants. 

You could even try growing fruit or vegetables which pollinators will love and can be used to explore diet and healthy eating.

Make seed bombs which the children could take home to plant. Look at the resources at the back of this pack for instructions.

Where do plants come from? Read Eric Carle's *The Tiny Seed* and then write a story about a plant of your own. 

For some plant science activities, have a look at Professor Plant's investigation ideas at the back of this pack. 

Read *Insect Detective* by Steve Voake and hunt for some of the minibeasts in your own green space. Keep a wildlife diary describing all of the animals that you see. 

CHANGING SEASONS

In the **winter** the Meadow is **dormant**. There are lots of seeds under the ground, waiting for the warmth of spring.



As it gets colder during **autumn** many of the flowers will die back. The pollinators which live through the winter will find somewhere to hibernate.



In the **spring** it gets warmer and the plants begin to grow again. Pollinators wake up from their hibernation and start to explore the Meadow in search of food.



In the **summer** it is warm and sunny and lots of flowers are in bloom. Pollinating insects spend their days flying around the Meadow looking for food.

URBAN WILDLIFE

Explore Together

All plants and animals need several vital things to survive. Can you name them?

Answer - Air, food, water, shelter and space.

Think about some of the animals you know. Where do they find these things?

Why do you think some animals may struggle to find these things in a city?

Can you think of any animals which have adapted to live in cities?

All living organisms are adapted to live in a certain place. We call this place a **habitat**. A habitat provides the things that an organism needs to survive, such as food, water and shelter. Without its preferred habitat, an organism is often unable to survive.

Unfortunately, as the number of people in the world increases, lots of natural areas are being destroyed to make room for people to live in. **Urban** areas such as towns and cities often have very few natural spaces left. This means there is nowhere for plants and animals to live. Some plants and animals have been able to adapt quickly to life in cities, such as rats, pigeons and foxes. But many have not adapted and their numbers are decreasing. As towns and cities continue to grow, this problem is only going to get worse.

Pollinators such as bees get all of their food from flowers. They can struggle to find enough food in towns and cities if there are few flowering plants. But we can help! If everybody living in a city planted some flowers of their own, there would be plenty of food for animals such as bees. If everyone's gardens or window sills contained flowers, bees could stop off for a meal whenever they felt hungry.



Here you can see a bee using his tongue to collect nectar from a flower

So we don't need to knock down entire cities and replace them with meadows, we simply need to increase the number of flowers in our towns and cities. Also, besides all of the wildlife they attract, flowers look really nice! Don't you think our towns and cities would look better if they contained lots and lots of flowers?

But it is important to plant the right flowers. Some popular cultivated flowers contain little pollen or nectar and provide very little food for pollinators. It is also important to plant a variety of different flowers as these will attract different pollinator species. Our 'Twelve pollinator-friendly plants' list at the back of this pack contains twelve different plants that a variety of pollinators will love.

Single or double flowers?

Some flowers have been specially grown to have lots more petals than normal! This is common with marigold plants, but is also done with other species. Below are two pictures of marigolds, the one with a normal amount of petals is called a 'single flower', and one with lots and lots of petals is called a 'double flower' (although it has more than double the amount of petals!).



Single flower



Double flower

Many people like double flowers because they are pretty and look interesting. Which do you prefer? Which do you think bees and other pollinators prefer? Butterflies have very long tongues which could reach down into the flower, but bees need to be able to get into the middle of the flower where the nectar and pollen are found. If there are too many petals then bees cannot get in! Because of this it is best to grow single flowers if you want to attract pollinators to your garden.

What about these? Could a bee get into the flower?



How do bees see flowers?

Bees have eyes which are very different from our own. This means that bees do not see the world in the same way that we do. Bees can see ultraviolet (UV) light, which we can't, and this means that they can see colours invisible to humans! Some flowers have patterns of these invisible colours which point bees in the direction of pollen and nectar (which bees like to eat). Although we can't see them with our eyes, we can use a special UV camera to get an idea of how these patterns look to bees. Have a look at the pictures below. Can you see how the bright colours highlight the middle of the flower where the bees can find pollen and nectar?

Visible Light



Ultraviolet Light



Photographs of two different flowers – the meadow buttercup (*Ranunculus acris*) and the common dandelion (*Taraxacum officinale* subsp. *vulgare*) - under visible and UV light.

Images © Bjørn Rørslett/NN


Dr Mike's survey


Here at the Museum we have first-hand evidence that our Meadow has helped attract wildlife. One of our Museum scientists, Dr Mike Wilson, is a specialist in a group of insects called leafhoppers and planthoppers. In September 2014, Dr Mike counted how many planthoppers and leafhoppers he could find in a 1m² area of the Meadow and a 1m² area of the mown grass next to it. He collected the hoppers using an instrument called a suction-sampler, which sucks the insects up into a net. He identified all the hoppers he found so he knew how many species there were. He found about 150 specimens in the Meadow, but only about 10 specimens in the grass next to the Meadow. He identified six different species of hopper in the Meadow and only two different species on the mown grass. This means that there were 15 times more hoppers, and 3 times as many hopper species, in the Meadow compared with the mown grass. He multiplied his findings by the size of the Meadow and calculated that there could be as many as 29,000 hoppers living in our Meadow! Next year we can sample again to see what has changed.





Arthaldeus pascuellus, one of the leafhopper species living in our Meadow


Activity Ideas

Think about the idea of a habitat. What is your habitat? Where do you get the things you need to survive? How are human habitats different to those of other animals? Have a class discussion about this. 

Write a story in which you are an animal living in a city. How do you feel? Where will you find food, water and shelter? 

Why not do a Meadow wildlife survey of your own? Count how many insects or plants you can find in 1m² of the Meadow (just count what you see, you don't need to collect them like Dr Mike did). Measure the edges of the Meadow and calculate its total size. Multiply the number of insects or plants by the size of the Meadow to give an estimate of the total number of insects or plants in the area. You could also try this at your school, or compare two areas like Dr Mike! 

Go on a wildlife walk around your local town or city (or use the area surrounding the Museum). Use a stopwatch to measure twenty minutes. What wildlife can you see in that time? What sort of places do these animals and plants live in? 

Perhaps you could go on a trip to the countryside and do another wildlife walk there. Do you see the same wildlife in this different habitat? Draw a table to record the similarities and differences. 

BEES

What type of animals are bees?

Bees are **insects**. They have six legs, a pair of antennae and three parts to their body - a head, a thorax and an abdomen.

Bees belong to an order of insects called Hymenoptera, along with wasps, ants and sawflies.

Did you know that there are over 250 different species of bee in the UK? We can divide these into three groups:

- **Bumblebees** – 24 species in the UK.
- **Solitary bees** - around 225 species in the UK.
- **Honey bees** – just one species in the UK, *Apis mellifera*.

Pollination & What do bees eat?

Honey bees get all of their food from flowering plants. They drink the sugary nectar and eat the protein-rich pollen produced by flowers. Pollen and nectar are usually found in the middle of a flower. The bright colours and sweet smells of flowers act as signals which tell the bees that there is food waiting. But it's not just the bees that benefit. In order for plants to make seeds, pollen from one flower must reach another flower. This process is called **pollination** and it is how many plants reproduce.

Many flowering plants rely on bees for pollination. This means that without bees, many flowering plants would not produce fertile seeds and would not be able to make new baby plants. As a bee drinks nectar from a flower, some grains of pollen stick to its body. Once the bee has finished drinking it flies to another flower for another meal. As it drinks more nectar, the pollen on its body gets rubbed onto the next flower. In this way the pollen is spread from flower to flower.



A bumblebee visits a poppy on our Meadow



Every tiny yellow speck you can see on this bee's head is a pollen grain!

The Bees Knees

Have you ever seen a bee with big yellow knees? When a bee gets covered in pollen not all of it rubs off on other flowers, some of it stays stuck to the bee's body. The bee then grooms itself, brushing its body with its legs and collecting the pollen in special areas on its legs called 'pollen baskets'. It then takes the pollen home to the hive for the other bees to eat!



A bee with full pollen baskets

Why are bees important?

Around one third of the food that we eat is pollinated by bees, so without them there would be significantly less food to go around. Many of our favourite fruits and vegetables rely on bees, including apples, pears, onions and carrots. Bees also have an impact on the meat that we eat. Some of the most important crops used to feed farm animals (such as alfalfa which is fed to cows) are pollinated by bees.

It is estimated that bumble bees and honey bees contribute over £200 million a year to the UK economy through pollination. There is even evidence that crops pollinated by bees produce more, better-quality fruit. Honey bees are also important because they are our only source of honey.



Some of our favourite foods are pollinated by bees. Clockwise from top left: apples, chocolate (cocoa), onions, strawberries, almonds and coffee

Honey bees

Honey bees get their name because these are the species of bee that makes honey. Most honey bees live in special houses called **hives** which are looked after by people. We call these people **beekeepers**.

Honey bees live in a big family group called a **colony**. During the summertime, there can be over 50,000 bees living in a single colony!

Every honey bee colony contains three types of bee:

- **Workers** – All worker bees are female (girls). There are thousands of workers in every colony. They do lots of jobs including cleaning the hive, collecting nectar and pollen, and feeding the larvae (baby bees).
- **Queen** – There is only one queen in each colony. Her job is to lay lots and lots of eggs.
- **Drones** – Drones are male (boy) bees. Their only job is to mate with new queens.



© Alex Wild
alexanderwild.com

A worker, a queen and a drone
honey bee

The queen

The queen bee is an egg-laying machine. During April and May she lays eggs day and night. It takes her around 20 seconds to lay a single egg – That means she is able to lay over 2,000 eggs per day!

A new queen mates just once with the male drones. After this brief encounter the queen has enough fertilised eggs to lay for the next three to five years.

Despite her grand title, the queen does not rule the colony. In fact she has a smaller brain than a worker bee. It is her egg-laying ability that makes her so special. The queen constantly emits chemicals (called pheromones) which all of the worker bees can smell. These chemicals tell the worker bees that the queen is still there and all is well.



A single bee egg

Worker bees

Worker bees usually live for up to 40 days during the summer. Any workers born in the autumn will survive in the hive until the next spring. The job that a worker does is decided by its age.

When a bee is born it must first clean out its own cell

1-2 days – Cleans cells and keeps brood warm

3-5 days – Feeds older larvae

6-11 days – Feeds youngest larvae

12-17 days – Produces wax, builds comb, carries food and performs undertaker duties

18-21 days – Guards hive entrance

22+ days – Begins flying from hive. Collects pollen, nectar and water



Worker bees leaving the hive to find food

Dancing bees

Worker bees have developed a way of communicating with each other using a special dance called a “waggle dance”. A worker returning from a place with lots of flowers (and therefore food) will “dance” on the vertical surface of the comb. During the dance, the bee runs around in a circle. On every rotation the bee will cut across the circle at a specific angle. This angle represents the angle in which the others should fly relative to the position of the sun. For example, a bee running straight down (i.e. 12 o’clock to 6 o’clock) is telling the others to fly directly away from the sun, and a bee running straight up (i.e. 6 o’clock to 12 o’clock) is telling the others to fly directly towards the sun. The dancing bee also tells the others how far they need to fly to reach the food source. He does this by wagging his abdomen. The more waggles, the further the other bees have to fly.

Our honey bees

We have our very own beehives on the roof of the Museum! Our two hives contain approximately 60,000 bees between them. A small group of Museum staff have been trained to care for the bees and check on the hive once a week from spring through until autumn. In the spring and summer they check that the queen is laying eggs and that the hive is “happy”. In the autumn it is important to ensure the hive has enough food. We provide the hive with inverted sugar syrup (a mixture of glucose and fructose) to ensure they are well-fed. Autumn would usually be the time to harvest honey, but because our bees are relatively new, we won't take any honey this year.



Here are some of the Museum's friendly beekeeping team

The last check of 2014 was performed on the 5th of November – where we made sure the bees had enough honey to last the winter. We then closed the hive and will not open it again until the spring.

If everything goes to plan, we aim to start harvesting honey next autumn. With the help of local company Nature's Little Helpers, we hope to produce a range of honey-based products which we can sell in the Museum shop.



Our beekeeping team being trained to look after the bees



One of our beekeepers opening a hive to check on the bees

Our hives add to a collection of beehives in the centre of Cardiff. There are also hives in Cardiff University, The Royal Hotel and St David's shopping centre.

Honey Bee Decline

The number of honey bees is falling all around the world. We call this decrease a decline. Scientists have found a number of possible reasons for the honey bee decline.

One big reason is that there are less flowers than there used to be. Natural habitats that have lots of flowers have been replaced by towns and cities in urban areas and farmland in agricultural areas. Remember that bees rely on flowers for food, so if there are no flowers then the bees will starve.

Another reason for the decline in honey bees is the Varroa mite. This little creepy-crawly is a parasite which attaches itself to bees and feeds on their blood (or haemolymph). Varroa mites lay eggs inside beehives and can spread between bees very quickly. Varroa mites weaken bees but a strong hive can stay healthy even with mites. However, Varroa mites also spread viruses and bees infected with these viruses often don't live as long as healthy bees. There are also other things which may contribute to the honey bee decline, including bacterial and fungal infections.



Here you can see a Varroa mite (the little brown blob) attached to a honey bee

The final reason for the honey bee decline is the use of nasty chemicals called **pesticides**. Farmers use pesticides to kill living things which harm their crops (known as **pests**). Pesticides which kill insects are called **insecticides**. The problem is that insecticides also harm insects which are not pests, including bees. There has been a variety of different pesticides used over the last few decades. Currently, there is fierce debate over a group of pesticides called neonicotinoids, which some scientists think are the major cause of the honey bee decline.

The decline doesn't necessarily have a single cause. It is probably caused by a combination of all of these things. Think of it like this:

Imagine that you had a virus and were feeling poorly. You go out to buy some food to build up your strength, but every shop or supermarket you go to is closed. There is nowhere for you to get something to eat. You start to get hungry and weak and feel even worse than you did before. After hours of searching you *finally* find a shop that is open. But the food that you buy is full of nasty chemicals! The more of the food you eat, the sicker the chemicals make you feel.

This is essentially what is happening to the bees.

It really is little wonder they are struggling to survive.

Urban areas such as towns and cities can actually be very good habitats for honey bees. There tends to be much less pesticide use than in **rural** and **agricultural** areas, and there are more people there to look after hives.

Why do honey bees make honey?

Unlike other bees, honey bees do not hibernate (go to sleep during the winter). Instead they cluster together in the hive to keep warm. In the UK it is too cold for honey bees to leave the hive during the winter and there are not many flowers for them to feed on even if they did. During the summer the worker bees make honey and store it in the hive. The bees then eat this honey during the winter so they don't need to leave the hive to find food.

Colonies usually produce two to three times more honey than they need, so a beekeeper is able to take some of the honey for people to eat without starving the bees.



The honey is stored in the hexagonal cells of the honeycomb

Activity Ideas

Read *The Beeman* by Laurie Krebs to learn more about honey bees and beekeepers. (L)

Write a story in which you are a honey bee living in a hive. Will you be the queen or a worker? What sort of jobs will you do? (L)

Do a bee survey, either in your own green space at school or at a nearby garden or park. How many bees can you spot? Are they all the same type? Use a guide book to help you identify the species. You could even take part in [BeeWatch](#) with the Bumblebee Conservation Trust. (N)

Build a hotel for solitary bees. Look at the resources at the back of this pack for instructions.

Make a class beehive art work. Draw a big beehive and have each pupil add a bee. Put your names underneath so you remember which bee is whose. Can be done using coloured pencils, paints, or fingerprint art.

During the spring, the queen bee lays an egg every 20 seconds. How many eggs would she lay in a minute? What about in an hour? (N)

An average beehive can produce around 15kg of honey a year. We have two beehives at the Museum, so how much honey should we expect to make? What if we had four hives? Or ten? (N)

The number of honey bees in a hive decreases during the winter. In the summer we have approximately 60,000 bees between our two hives. If we were to say that the number dropped to 6,000 during the winter, what percentage of the summer bees live in the hive in winter? (N)

Honey bees use the waggle dance to communicate with each other. How easy is it to talk to each other using only dance moves? Make up a dance that tells your friends something. Remember, no talking!

Make and decorate a bee plane (template at back of this pack).

Bees are a type of insect. Can you think of other types of insect? What do all insects have in common? How are insects different from other minibeasts?

Learn the insect body parts by singing the 'Head, Thorax, Abdomen' song (lyrics at back of this pack).

Design a poster to inform people about the decline in bees. What information will you include? Who do you want to look at it? What pictures should it have? (L)

Record a food diary of everything you eat in a day (or week). Research foods that come from bee-pollinated plants and erase all of these items from your menu. What would be left for you to eat without bees? Discuss this as a class. (L)

Bees are in decline because of the actions of humans. Research other animals that are in decline and discuss the reasons. (L)

KWL Chart

You may like to prepare the children for their visit to the museum by completing a KWL chart.

Discuss with the children what they already know and what they want to know before the visit. After the visit, the column *What have I learned?* may be completed.

The chart may be prepared by each individual child, a group of children or just one KWL chart for the whole class.

What do I K now?	What do I W ant to know?	What have I L earned?

Twelve pollinator-friendly plants

Do you want to help save the bees? Do you want to see more butterflies around your school? Here are some plants that pollinators love! You can plant them in your school garden or grow them in pots to create a green space at your school.

1. Sunflower



2. Lavender



3. Cornflower



4. Buttercup



5. Rosemary



6. Buddleja



7. Poppy (Welsh!)



8. Phacelia



9. Marigold



10. Red Clover



11. Penstemon



12. Primrose



TOP TIPS:

- Some of these plants come in lots of different colours.
- Buddleja is also known as the Butterfly Bush!

These are just a few ideas to get you started... there are lots of others! Can you find out the name of another plant that pollinators love?

The easy-peasy step-by-step guide to creating a mini-meadow!

Step 1: In the spring, find a small patch of ground (better check you are allowed to grow a meadow there!).

Step 2: If it is grassy, dig up the grass!

Step 3: Rake the soil or use a spade to turn it over.

Step 4: Get some seed of different kinds of plants (see the next page for some ideas). You could buy some seeds, ask your family and friends if they have any from their garden, or come to one of the Museum's 'Seed Swap' days.

Step 5: Scatter the seed all over your meadow area and rake lightly.

Step 6: Water regularly (especially if there is no rain).

Step 7: See what grows!

Step 8: In October, cut the meadow and leave the cuttings lying on the meadow.

Next Spring: Start again at Step 4!

TOP TIPS:

- Keep you mini-meadow mini! Around 2 metre² is fine. If it is too big it may be a lot of work and expense. Keep it cheap and fun! (You can always expand if you get the bug!)
- Most wildflowers grow in nutrient poor soil, so do not add fertilizer.
- Do not use pesticides or herbicides, this includes slug pellets and weed killer. These chemicals will harm your flowers and visiting minibeasts.
- Think of your mini-meadow as an experiment. Not everything you plant will grow, and some things may grow faster than others, so don't be disappointed! Keep a record of what you planted and what grew the best.

Mini-meadow plants

There are lots of different plants that you can grow in your mini-meadow. Be adventurous! See how colourful you can make it! You can buy 'mixed wildflower seed' or choose different kinds of plant seed. Plants can be divided into two groups, **Annuals** and **Perennials**.

Annual plants

Annuals are plants with a life cycle that lasts only one year. They grow from seed to flower, produce more seeds and then die all in the same year. They then need to be replanted each spring. Most **annuals** bloom for a long time, for example from spring to the end of summer.

Examples:



Poppy



Cornflower



Corn marigold

Perennial plants

Perennials are plants that grow for several years. After they are planted they grow and flower again each year. They do not need to be replanted each year, but do not live forever. They may last 3 to 5 years. Some **perennials** bloom for a shorter time, for example a few weeks in the spring, and some may not flower in the first year you plant them.

Examples:



Buttercup



Red clover



Ox-eye daisy

TOP TIP: It is a great idea to have a mix of Annuals and Perennials in your mini-meadow!

Make your own seed bombs

Seed bombs are a great way to spread flowers and brighten up your garden or school grounds. They are quick, simple and lots of fun to make. Don't worry, they are not as dangerous as they sound!

You will need

Air-drying (potters) clay

Compost/potting soil

Seeds

Water

Egg carton / other container



Instructions

Step 1: First you need some clay. You can make the bombs any size you like, but smaller ones work best. A piece of clay roughly one inch in diameter works well.

Step 2: Add equal amounts of soil and seeds to the clay. You're aiming for a ratio of around 5 parts clay to 1-2 parts soil and 1-2 parts seed.

Step 3: Use your fingers to squash everything together so that the seeds and soil are distributed throughout the clay. If the mixture is crumbly then add a few drops of water.

Step 4: Roll clay into ball (or whatever shape you like) and you have yourself a seed bomb!

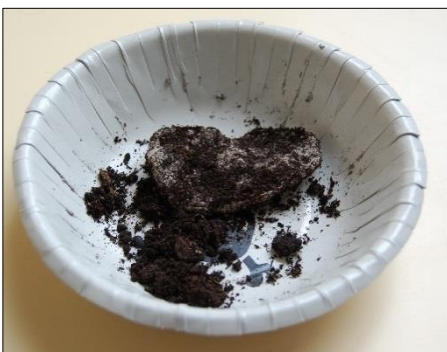
Step 5: Find somewhere to store them. Old egg boxes make great containers.

Step 6: The next step is to allow the seed bombs to dry. You need to do this for at least 24 hours, either next to a window or in a dry outdoors area such as a garden shed.

Step 7: Now you need to decide where to throw your seed bomb! For best results, find somewhere in your garden that gets a lot of sun. It works best if the bombs land on disturbed soil.

Step 8: If you'd prefer you can plant them in plant pots (one bomb per pot) or in a window box (up to four per box). There is no need to bury them under soil, just sit them on the surface.

Step 9: Don't forget to water your plants!
You should start to see seedlings after roughly two weeks.



Make your own bee hotel

Not all types of bees live in hives like honey bees. Some bees, called solitary bees, live on their own and make little nests in a variety of different places. A bee hotel provides a safe place for these bees to nest. Having a bee hotel in your school is great for two reasons. Firstly, it helps raise the number of bees in the area (which as we all know is very important). Secondly, a bee hotel gives you the opportunity to see bees up close and to watch all of the interesting things they get up to.

Don't worry about getting stung! Solitary bees are very calm and won't sting you if you do not upset them. However bees will not nest in a place where they don't feel safe, so once you have hung your bee hotel try not to disturb it too much (don't poke your fingers in!) and hang it somewhere away from busy areas.

You will need

An empty 2 litre drinks bottle

Bamboo or other hollow stems (enough to fill bottle – roughly 15cm)

One metre of string

A pair of scissors

A pair of secateurs or small hacksaw

Instructions

Step 1: Cut the top off of the plastic bottle (children will need an adult to help with this). This should leave you with a roughly 15cm long plastic cylinder which is sealed at one end.

Step 2: Next use the secateurs or hacksaw to cut the bamboo to the same length as your bottle. This will need to be done by an adult – it may be a good idea to prepare this beforehand.

Step 3: Pack the lengths of bamboo into the bottle as tightly as you can.

Step 4: Tie a loop of string quite tightly around the bottle about a quarter of the way in from one end. Repeat at the other end.

Step 5: Use another length of string to connect the two loops, making a handle to hang your bee hotel from.

Step 6: Now you need to choose where to hang your bee hotel, ideally somewhere sunny and sheltered from the wind. South or east-facing walls/fences are best. Make sure that it is at least 1m above the ground, and that it isn't overshadowed by plants and buildings too much during the day.

Step 7: If you are hanging your hotel on a wooden surface then you can hammer in a few nails to hang it from. You can also attach the hotel to stone or masonry, but you'll need a drill for this.

Step 8: Make sure that the hotel is level. If you can't get it perfectly horizontal then make sure the sealed end is higher than the open end. This will prevent water from collecting in the bottle.

You should aim to hang your bee hotel in early spring.

Insect Song

(TO THE TUNE OF HEAD, SHOULDERS, KNEES AND TOES)

“Head, thorax, ab- do- men ab- do- men

Head, thorax, ab- do- men ab- do- men

With three legs here, and three legs there

And two antennae on my head,

On my head!”

Neu, yn Cymraeg:

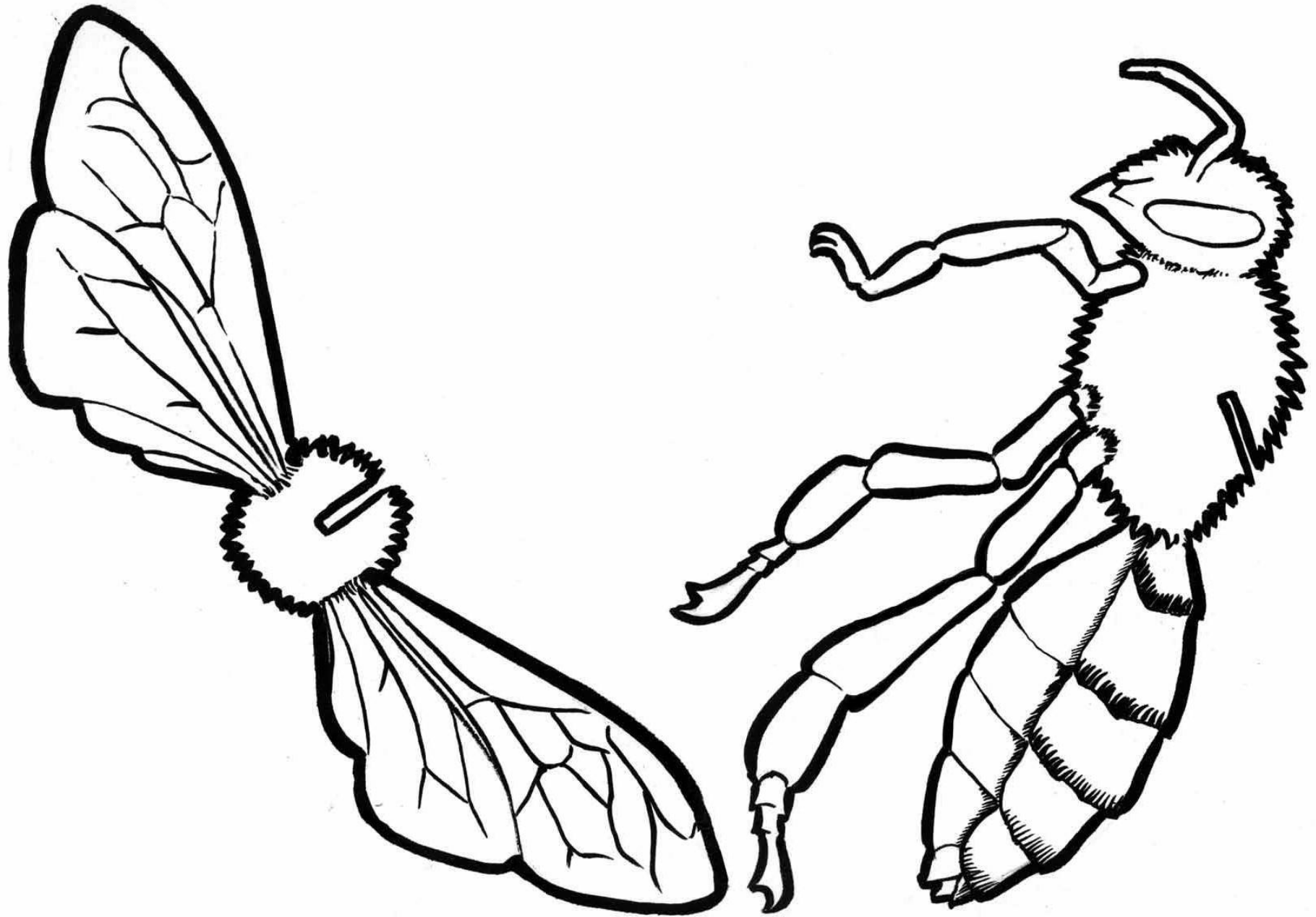
“Pen, thoracs, ab- do- men ab- do- men

Pen, thoracs, ab- do- men ab- do- men

Tair coes chwith a thair coes dde

A dau antenna ar fy mhen

Ar fy mhen!”



Urban Meadow word-search

r	o	o	t	s	l	k	k	e	o	v	h	i	e	g	s
a	b	f	e	f	p	x	c	h	a	b	i	t	a	t	b
n	u	b	h	o	f	n	q	l	w	r	a	a	m	n	m
e	u	j	i	w	p	o	l	l	i	n	a	t	o	r	p
c	e	y	v	z	z	o	k	v	m	w	o	r	k	e	r
t	g	o	e	a	m	e	a	d	o	w	x	a	p	c	w
a	p	h	r	r	o	q	i	f	s	n	p	v	f	j	u
r	e	z	g	d	j	u	l	p	r	h	o	w	l	m	r
r	t	f	e	v	l	e	f	e	m	k	l	c	o	y	b
i	a	w	e	a	m	e	m	u	a	l	l	b	w	f	a
l	l	w	r	y	t	n	c	s	i	f	e	a	e	t	n
u	o	u	e	n	h	g	x	o	o	y	n	q	r	j	u
v	r	c	a	w	p	e	s	t	i	c	i	d	e	p	r
f	h	l	c	t	o	q	u	e	u	h	j	a	i	d	e
o	p	e	y	m	h	o	n	e	y	f	s	m	b	e	v
d	i	v	e	r	s	i	t	y	x	c	w	o	b	d	a

bee

flower

habitat

hive

honey

leaf

meadow

nectar

pesticide

petal

plant

pollen

pollinator

queen

roots

rural

urban

worker

Botanical Illustration

Botanical Illustration means making accurate lifelike drawings of plants.

Illustrations are still used in many books instead of photos because an illustration can show what can be seen with the naked eye (like the correct number of petals and stamens in a flower) as well as what we cannot easily see (like the root structure, or different stages of development).

Botanical illustration has been practiced for centuries, even the Romans did it, and by the medieval period we find some wonderful, lifelike pictures of plants in illuminated manuscripts. It began because people used the plants for medicine and needed to recognise the correct plant. This art form really came into its own when people started exploring and wanted to record details of plants that would not survive a long voyage home.

STUDY: Choose a flower and look at it closely. Is it easy to see how the petals join the base of the flower or what shape the stem is? Are any of the parts more than one colour? Keep these details in mind as you make your drawing.

PRACTICE: Make a rough sketch of your plant at life size and at the angle at which you want to draw it. This is a quick practice to help you get the size and shape right and should only take a minute or two to do. If you are lucky you might even be able to trace roughly round your plant. This just gives you something to refer to if you get confused later on.

SKETCH: On a fresh sheet of paper, make a very light sketch of your plant at life size to get the flower, leaves and stem in exactly the right position. Don't worry about detail yet.

DETAILS: When you think the sketch is right, you can start drawing in the detail of your plant. Make sure you get all the petals that you can see in the flower, and show if they bend or curl at all. Look at the shape of the stem, is it round or square? Does it have hairs or lumps that you can add to your drawing? (Keep your pencil sharp for fine details!) Are the leaves smooth or frilly, and are there veins or any damaged parts that you want to record.

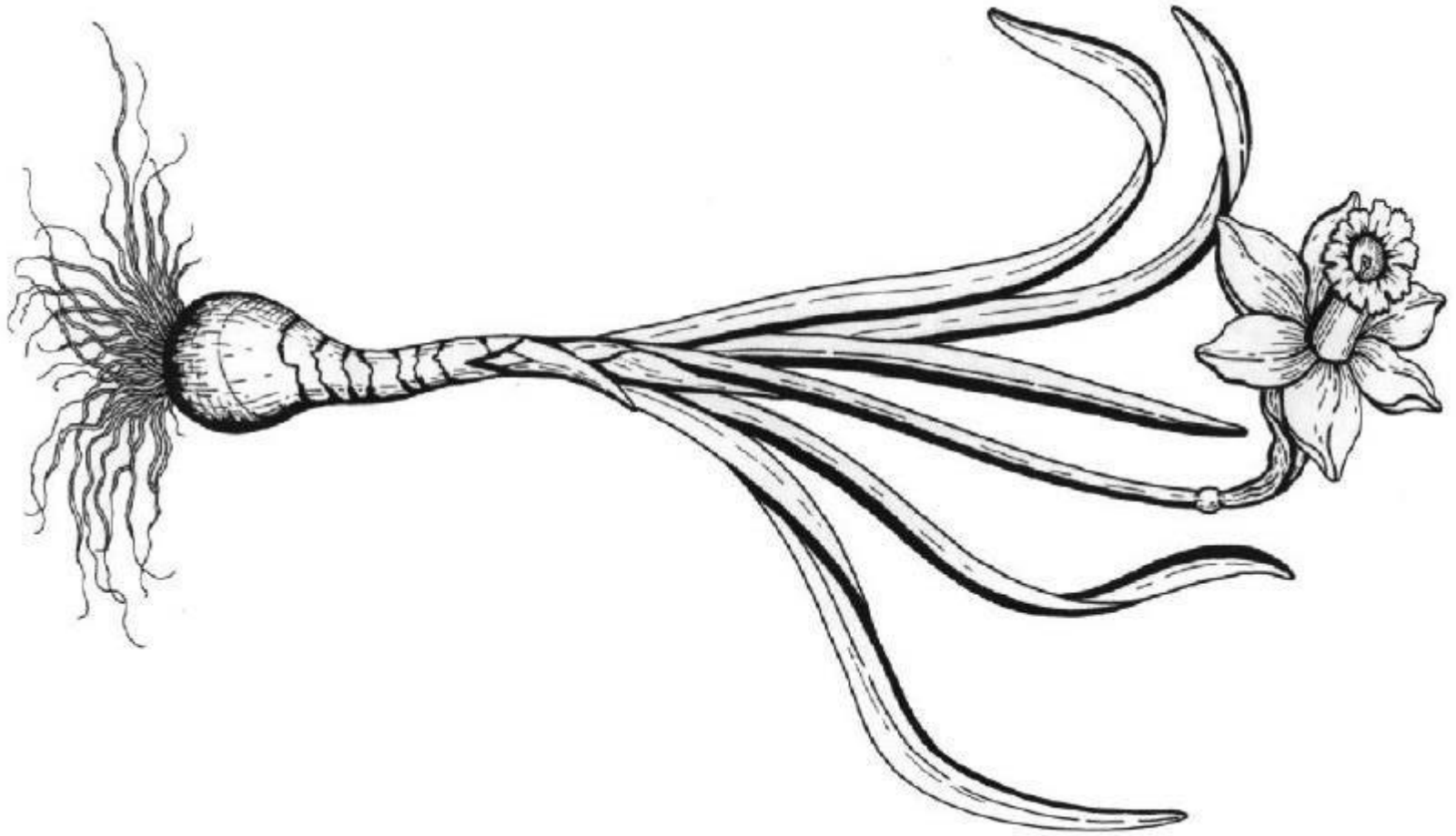
Rub out lines that are no longer needed as you go.

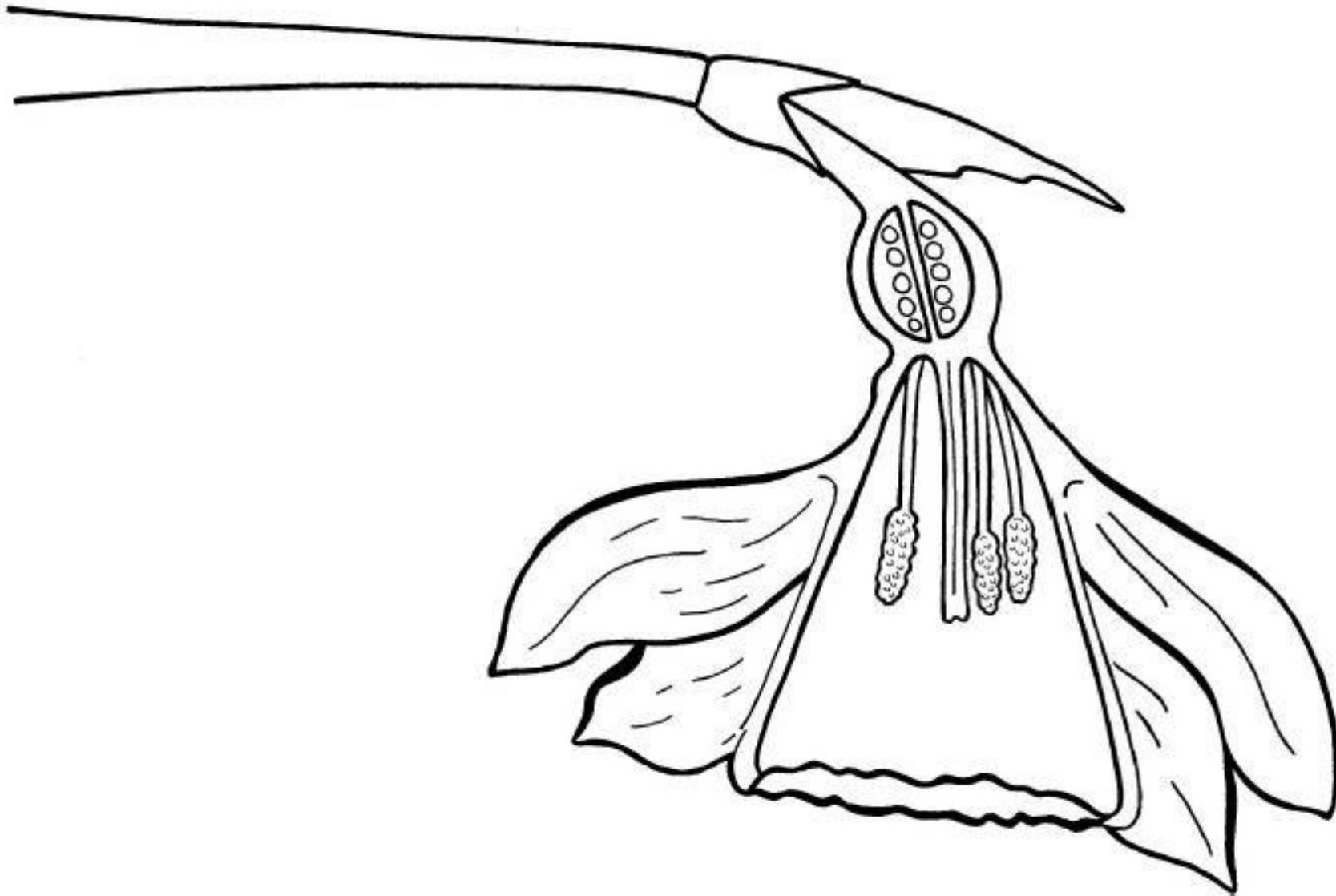
LABEL: It is very important to label your drawing so that other people can see what each part of the plant is. Labelling drawings is also a really good way of learning new scientific words. Here are some things you could label on your plant: stem, leaf, petal, root, stamen, anther, filament, pistil, stigma, style, and ovary.

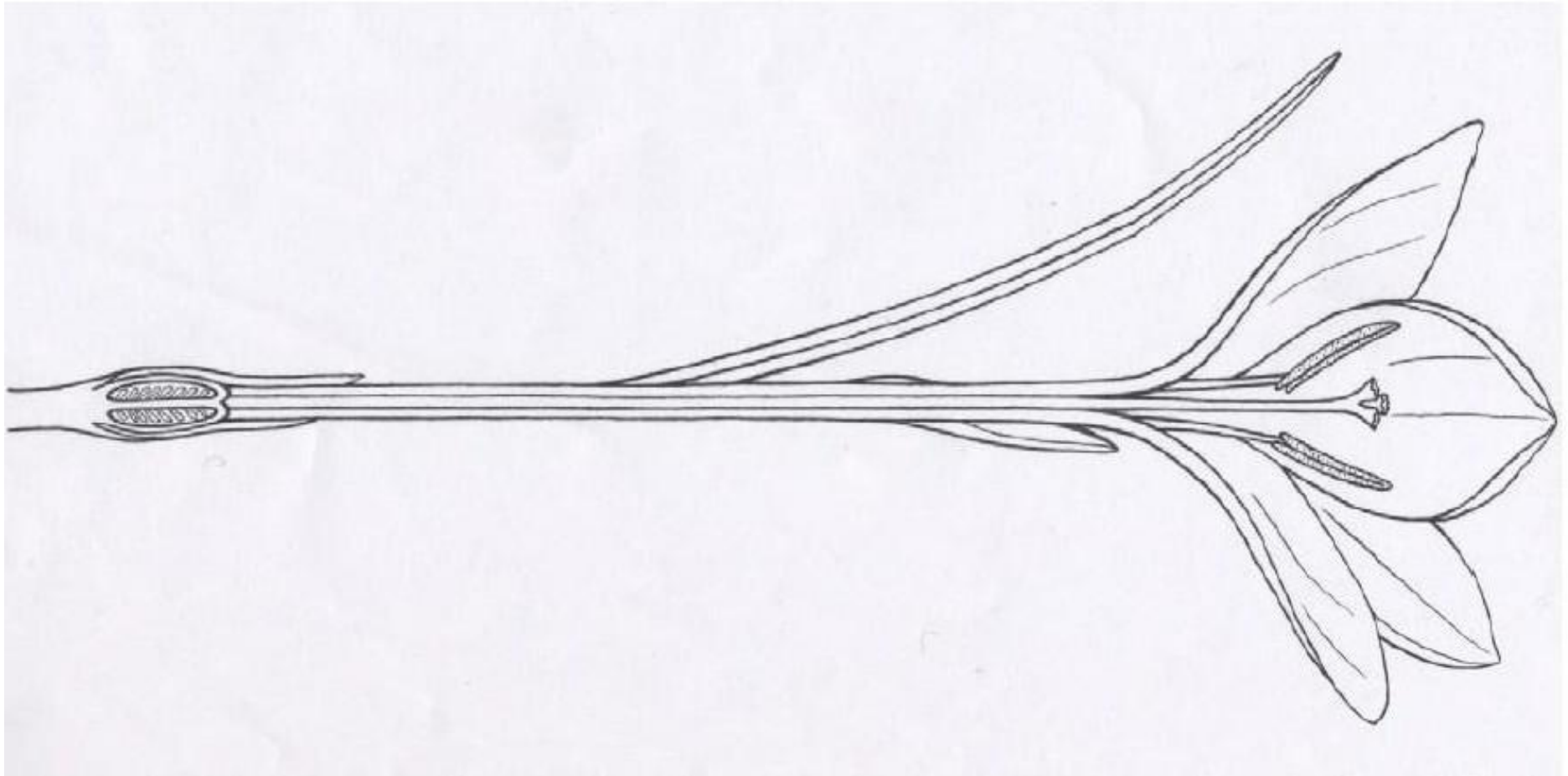
COLOUR: Once you have a pencil drawing that looks just like the plant you are looking at, you can decide whether to colour it or not. Coloured pencils work really well for this, and paint is fine but you will need to use very delicate layers of paint to get all the detail. Colour can help you show details that your pencil can't easily record, like shiny areas or different colours in the same leaf.

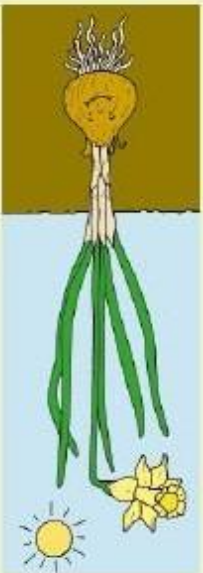


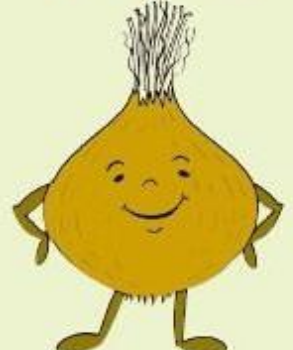
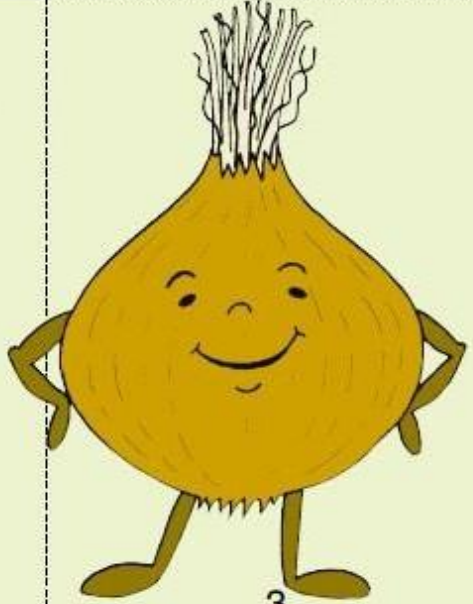
Don't forget to sign your work!

On the next few pages there are diagrams of some plants for you to colour in and label, or you can draw and label your own flower







<p>7</p>  <p>The new leaves make more food and the flowers make seeds.</p>	<p>6</p> <p>What do bulbs do in the Spring?</p> <p>When a bulb thinks it's warm enough outside, it starts to grow roots and buds.</p> <p>The bulb uses its stored food to grow into a plant with leaves and flowers.</p>	<p>5</p> 	<p>4</p> <p>What do bulbs do in the Autumn and Winter?</p> <p>They sleep underground during the cold winter months - waiting for some warmth...</p>
<p>At the end of Spring...</p> <p>The plant dies back and stores all its food in the bulb - ready for next Autumn!</p>  <p>"Quite clever, I think!" Professor Plant</p> <p>8</p>	<p>The Secret, Undercover Life of a Bulb</p>  <p>by Professor Plant</p> <p>1</p>	<p>Why are bulbs fat?</p> <p>Bulbs look fat because they are full of food and water.</p> <p>2</p>	 <p>3</p>

Make your own mini-origami booklet!

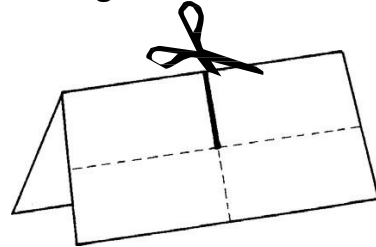
The Secret Undercover Life of the Bulb

by Professor Plant

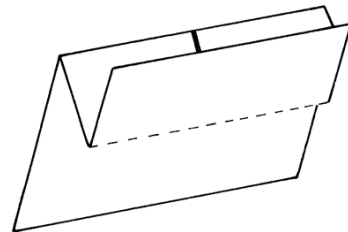
Learn about the life of a bulb by making your own mini-origami booklet.

How to make:

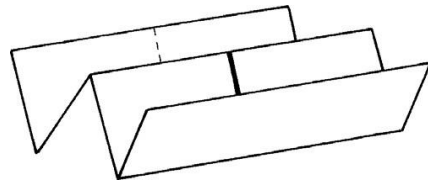
1. Fold your paper like this then cut through the **thick** black line.



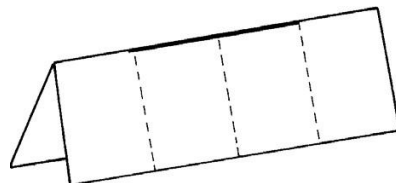
2. Fold along the dotted line like this.



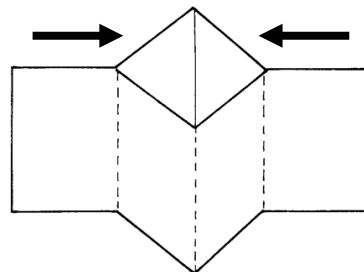
3. Then do the same on the other side.



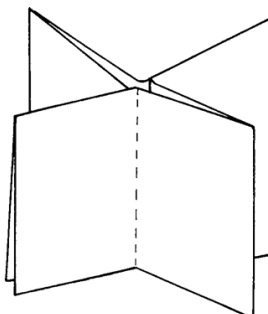
4. Open out your paper, then fold it along its length.



5. Push the two ends together like this.




6. Then fold into a booklet making sure the cover is at the front.



Professor Plant's investigation ideas

Investigation 1: Will a crocus open early in a warm room?



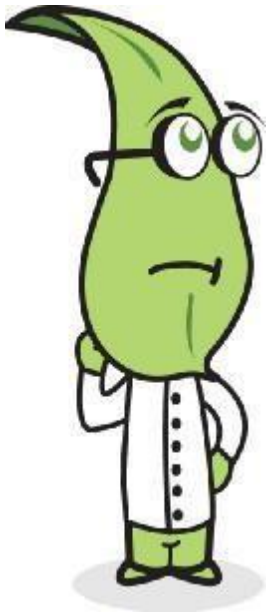
Just before your crocus flowers are ready to open and look like this  bring just **one or two** into a warm classroom. Discuss what you expect to happen & why. Wait with a timer and digital camera and make a record of any changes. Note down the time of the changes if you like. Next, place the flower outside, perhaps on the windowsill and watch what happens from the inside. Again, take notes, photographs and record the timings.



What to expect: The flower should open very quickly once brought inside – especially if your room is very warm. It should spring open as you watch it. The class can make recordings and perhaps discuss why they think this happened. The warm air has tricked the flower into thinking it is a warm day. Discuss with your pupils why it is important not to do this with all your crocus - as it will make false results for the main spring bulb investigation. How does the crocus move? Heat makes the inner surfaces of a flower's petals grow. So when the temperature goes down, the outer surfaces grow faster than the inner ones, thus making the flower close.



Investigation 2: Does your crocus close in the evening?



Once your crocus is open visit it at different times of the day to see when it opens, perhaps just before lunch and just before the end of the school day. Draw and note down any differences and explanations you may have.

What to expect: Unless your crocus petals are damaged by heavy rain or wind it should open as the temperature increases during the day and close as the day gets cooler in the late afternoon.



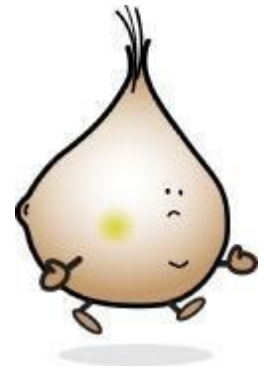
Why do they close at night? When flowers close temporarily for the night they are effectively in standby mode, protecting their delicate reproductive parts and pollen while they are not in use. The pollen is separated from the dew that forms during the night, keeping it dry so that it can be dusted onto a passing insect the following day. Some flowers remain closed until sometime after dawn, and only reopen when the day is warm enough for the dew to have evaporated.



Investigation 3: Do daffodil flowers always face the sun?



Look at your daffodils. Are they all facing the same direction? Discuss which direction you expect them to face and why? Find out which way they are facing by using a map or compass and a piece of chalk to note South, East, West and North on the school yard. Alternatively, use a piece of large paper, reference points (e.g. buildings) or the template provided to record the direction. Ask each pupil to note the direction of their flower. Discuss your expectations and compare them with the results.



What to expect?

Daffodils should face the South rather than the north to maximise the sunlight they receive. However, if they are unable to face the South because of a wall or building in the way - they will face the sunniest direction.

To expand this investigation you could look at what happens if you turn your flower away from the sun? Will it grow towards the sun? Investigate with some daffodils throughout a week. Over a few days it will grow back towards the sunlight. Plants that grow towards the light are called **Phototropic**.



Investigation 4: Do daffodils tilt or move their heads throughout the day?



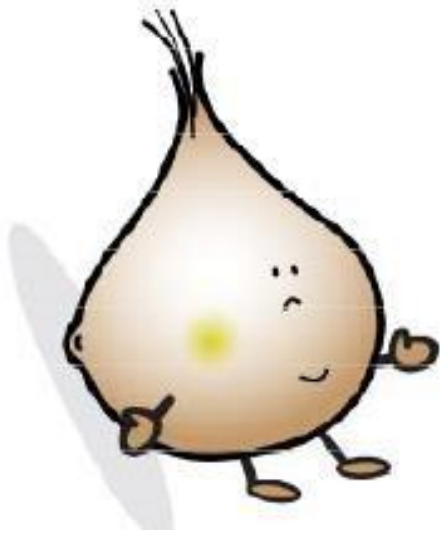
This experiment is best done on a calm and sunny day – because the wind will really affect the results. The sun moves throughout the day from East to West. Do your daffodils move their heads with the sun throughout the day?

Discuss your expectations & how you will record where the sun is & what direction your flower is facing. You may wish to draw reference points on the floor with chalk or use the template provided.

On the template you can mark out with a ruler the direction of the sun and the direction your daffodil is facing at certain times throughout the day. Perhaps record 1st thing in the morning, just before lunch and at the end of the school day. You could use a digital camera to record any movements. You may also wish to set up a control for your experiment, by placing one daffodil in a dark room – to see if it behaves differently from those outside. You may also wish to compare temperatures throughout the day.

Things to discuss: Does the position of the sun change throughout the day? Does the direction your flower change throughout the day? You may also wish to discuss how the sun can be used to help us find the direction if we are lost.





What to expect: Providing there is no wind and the sun is shining the flower heads should tilt towards the sun throughout the day. Although there are scientific studies that refer to daffodils tracking the sun throughout the day – there is also some disagreement amongst gardeners – so this is something that truly needs more investigation. Please let Professor Plant know your conclusions. How you set up this experiment is very important – you need to give your pupils space to work around their pots without moving them or you may wish to secure a few pots in place with bricks or blue tack. Or discuss how the sun can be used to help us find the direction if we are lost.

Plants that track the sun throughout the day with their leaves or flowers are called **Heliotropic**; a sunflower is typical example of a heliotropic plant. Heliotropism was first described by Leonardo da Vinci.



ESD&GC link: Discuss setting up a solar panel – which direction would it need to face etc. Some solar panels track the sun by using motors and electronic control systems, but some scientists believe that we can mimic the plants that track the sun by using materials that expand in the heat. This could be very useful in developing countries, where motor-based sun-tracking panels are not affordable.

Literature link:

Discuss William Wordsworth's poem the Daffodil then write your own poems about daffodils or the spring. (p.t.o).



Daffodils (1804)

I wander'd lonely as a cloud

That floats on high o'er vales and hills,
When all at once I saw a crowd,
A host, of golden daffodils;
Beside the lake, beneath the trees,
Fluttering and dancing in the breeze.

Continuous as the stars that shine

And twinkle on the Milky Way,
They stretch'd in never-ending line
Along the margin of a bay:
Ten thousand saw I at a glance,
Tossing their heads in sprightly dance.

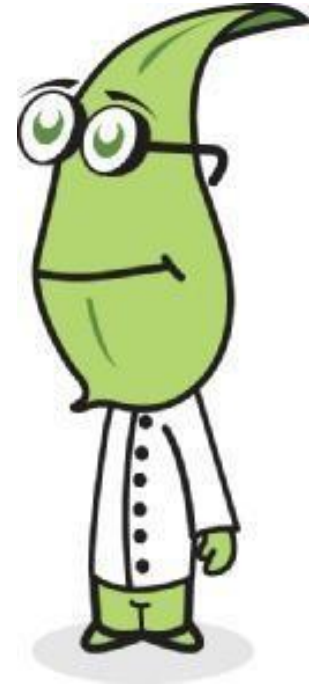
The waves beside them danced; but they

Out-did the sparkling waves in glee:
A poet could not but be gay,
In such a jocund company:
I gazed -- and gazed -- but little thought
What wealth the show to me had brought:

For oft, when on my couch I lie

In vacant or in pensive mood,
They flash upon that inward eye
Which is the bliss of solitude;
And then my heart with pleasure fills,
And dances with the daffodils.

By William Wordsworth (1770-1850).



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