Planting Science
real research for engaged education
CREATED BY THE ARC CENTRE OF EXCELLENCE FOR TRANSLATIONAL PHOTOSYNTHESIS

Planting Science

Year 1

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Year 1: Where the wild things grow

Unit at a glance

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Plants grow, change and have offspring, but it can be hard to see it in action. This unit shows the unique ability plants have to change to suit the environment in which they're planted

1 Where the wild things are

In the book 'Where the wild things are', there's a forest growing in Max's room. Would a forest really be able to grow inside? Students investigate.

Science snapshot

Meet Min Chen. Min works on finding photosynthesis in the most unlikely of places.

2 Leaves like light

In this interactive display of bubbling photosynthesis, students will be able to see why leaves like light. They'll also measure some leaves for themselves.

3 Word play

Students play a game of dominoes where they match up the picture of a plant part to the written word.

4 Where the wild things grow

Students have seen that leaves like light. But what if a plant is grown in the shade? How far will it go to grow?

Quickshot

What's in a name? A 'wild type' in research is the unchanged plant. The mutant is the one that's been changed somehow.

5 Draw your conclusion

Students have conducted their own experiment, now they'll need to discuss their results and draw their conclusion

Science snapshot

Meet Lily Chen. She's working to see how sugars are transported in plants. See Lily's work painted by artists for Science Week.

Optional inclusions and notes

Curriculum links & learning outcomes

Teacher information included in a table at the end of this document

Photosynthesis is the process of plants using energy from the sun to convert carbon dioxide and water into sugar and oxygen

Year 1

Where the wild things grow

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Plants live in places where their needs are met - even though they can't move!! This unit shows how their unique external features allow them to grow where they're planted.

About this unit

Plant science can be hard to show quickly and easily, especially showing that plants have needs and that they must adjust, and adapt to their environment or die trying. But that is what makes plants different to animals. Plants aren't able to get up and move if their environment is uncomfortable or not ideal to their growth. Instead they must change to suit their environment.

This unit includes practical, easy experiments to enthuse students with real science, and matches their activities up to the real research that's happening in science now to pique their curiosity.

About the program

These teacher resources have been prepared by the ARC Centre of Excellence for Translational Photosynthesis. The Centre is working on maximising photosynthesis inside the leaf, to translate it into higher crop yields for farmers. It's hoped that this will secure food supplies for future generations. The lessons are designed to link the research of the Centre with the Australian Curriculum, creating a direct connection between the students, the research and the scientists.

The lesson plans focus on students achieving science inquiry outcomes by using a modified version of the scientific method. Students will create real tests, create their own hypotheses, test and measure the outcome of their inquiry based experiment.

To work the scientific method accurately, students need to be able to measure and show their results. Including data collection and display in the classroom naturally leads to maths in context activities, which represents what happens in real research.

Structure

The lessons have been modelled on the '5 E's' method for teaching and learning, created by Bybee et al, and popularised by Primary Connections. A number of optional inclusions have been incorporated into the program to supplement class learning where required. This may be to achieve deeper learning on a particular outcome, or to familiarise students on a concept or technique before they run their actual experiment.

Science Snapshots provide an important connection to the science. They describe a real research project or technique, and introduce the reader to a scientist working in the field.

Extra information has been included on the trickiest experiments, to troubleshoot if an unexpected outcome occurs. Of course, in science, many experiments end up with an unexpected result, so if this happens, you'll be in good company!

Budget

Lessons have been designed to maximise educational outcomes, while keeping the cost manageable for tight budgets. The cost of materials to deliver each unit is designed to average out at around $20 per lesson for the whole class. All items used are commonly available at supermarkets, home maintenance stores (like Bunnings), health food shops or on eBay.

Copyright Information

A plant growing where its needs are being met.

About

Where the wild things are

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Students may or may not be familiar with the concept of photosynthesis. This lesson introduces plants and plant growth to them, and encourages observation of the properties of light.

This lesson comes in two parts, reading the book 'where the wild things are' to introduce the plant science topic, and a light investigation to show light refracted from the sun, or putting the rainbow back together with torches.

Part 1: Storytime: Where the wild things are

Teacher information

Reading the story starts a conversation about plants, what they need to grow, and where they'll find it.

Learning outcomes

Students will be able to:

- identify the parts of a plant.
- identify what plants need to grow.
- understand what goes into, and out of photosynthesis.

Materials

- book: Where the wild things are by Maurice Sendak

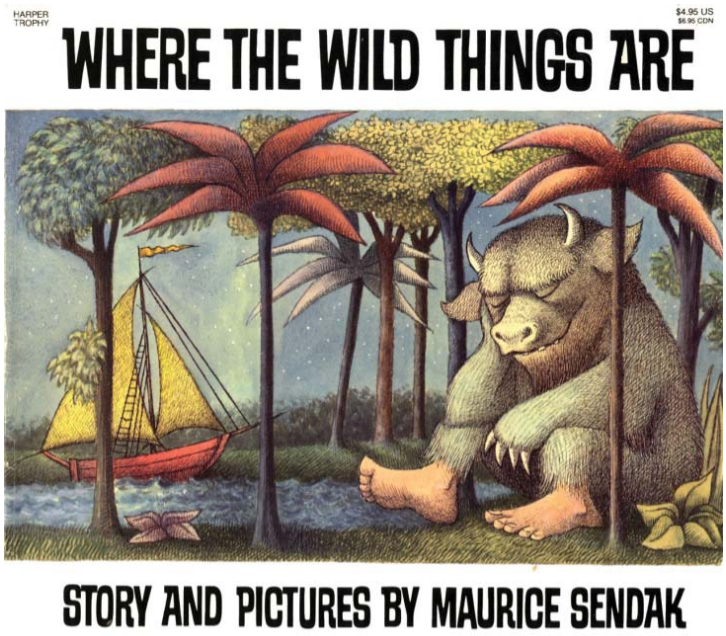
Instructions

1. Pair students off and ask them to do a think, pair, share, focussing on what plants need to live
2. Do a page walk of the book 'Where the wild things are', noting all the living things in the book.
3. Where does the first forest in the book grow? Students might notice it's in Max's bedroom.
4. Read the whole story.
5. Would a forest really be able to grow indoors? If not, why not?

For the word wall

Oxygen

Carbon dioxide



The forest in Max's room.

Science Snapshot
Min Chen

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Did you know that plants absorb different amounts of different colours of the light spectrum? Min Chen investigates.

Meet Min Chen.

Ever since Min was a child she's been curious about the world around her. She says her work looks hard, but in fact it's been easy because at every step of the way, she's followed her childhood dream.

Min says her lab is an extension of her kitchen - somewhere she can explore and fulfil her curiosity and it's where she feels most relaxed and happy.

A bit about Min's research

In 2010 Min's curiosity led her to investigate a group of large, ancient structures called stromatolites in Shark Bay, Western Australia. What she discovered there, no one had ever seen before. Min found a new type of chlorophyll. Chlorophyll is the pigment that absorbs light energy that's then used in the process of photosyntheisis.

It's called chlorophyll f and it can photosynthesise under very low light conditions, like inside stromatolites.

Different leaves absorb different amounts of the different colours of hte light spectrum. When you think of the colours of the rainbow, most leaves absorb the red light and the blue light the best. The green light energy then reflects back to your eyes, and that's why leaves are green.

The chlorophyll Min discovered, the chlorophyll f, can absorb light we can't even see - the far red light energy on the spectrum of light.

Min and her team are working to modify photosynthesis in food crops to work similarly to the chlorophyll f, so it can absorb more light and grow more food.

More about Min

What got you into science? Curiosity. I am interested in knowing how, why and what from surroundings since I was a girl. Such curiosities result into my passion about sciences.

What do you enjoy most about research? Something are new. Every morning you have new hopes for new results, some unexpected results and new challenges.

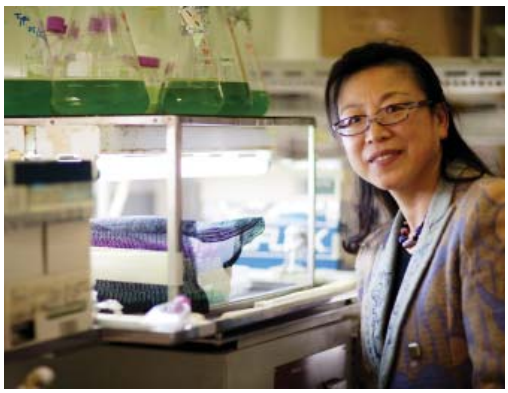
What do you see as challenges for your field of research? New concepts, new questions, and potential new directions in the research.

Who are your science heros? During my high school, I had two favourite subjects, Physics and Biology because of my teachers. I learned how to assembly my first radio from my physics teacher (such knowledge is still useful for me to develop LED light set-up for cyanobacteria/plant culture facilities. Knowledge across disciplines are important for opening your mind and constructing your creative thoughts

I was pleased to have opportunities meeting with many great scientists in photosynthesis research, Talking with them, you can learn more than reading a book (also a quick way to get frontier knowledge in the field). such as Prof Jan Anderson, Prof Hugo Scheer, Prof Robert Blankenship, Prof Jim Barber, Petra Fromme, and others.

What else do you have underway? I enjoy cooking, knitting and sewing if I have time. I also like travel (just wandering around "unknown" cities) for learning different cultures.

It is said " you can do your experiments if you know how to cook".



Min Chen in her lab.

Photo credit: University of Sydney

Stromatolites at Shark Bay, Western Australia.

Where the wild things grow

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Students may or may not be familiar with the concept of photosynthesis. This lesson introduces plants and plant growth to them, and encourages observation of the properties of light.

Part 2: Light investigation

Teacher information

The students have probably guessed that a forest couldn't really grow in Max's room. Do they know why? The light that comes from most light bulbs is a lower intensity than the light that comes from the sun. It also doesn't contain the full spectrum of light, like the sun does.

Some light bulbs are very bright, and a few even contain the full spectrum of light. These are the lights used for hydroponic plant growth.

Experimenting with light refracting prisms will show. If the lesson takes place on a cloudy day, students can practise putting the rainbow back together with torches fitted with coloured filters, instead of separating it from the sunlight with refracting prisms.

Learning outcomes

Students will be able to:

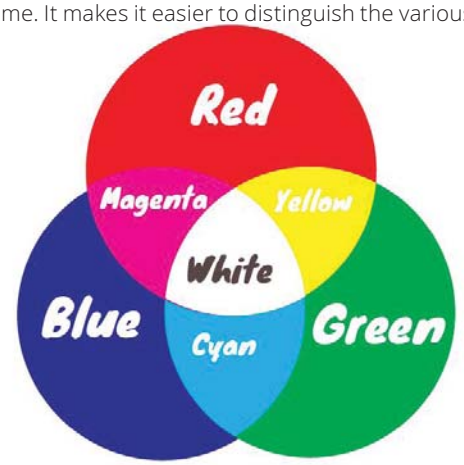
- see how different light comes from light bulbs and sunlight.

Materials

- light refracting prisms, magnifying glasses, glasses of water, crystals etc.
- several table lamps with regular light bulbs (these can be any light or LED)
- sunlight if available, or,
- 3 torches with coloured filters on them, one red, one blue and one green. Filters can be made using clear plastic and permanent markers.
- optional, for use with torches, paper with holes punched out of it (using a hole punch), so students can only look at small parts of the shining coloured light at a time

Instructions

1. Let students investigate light with refracting prisms to refract out the sunlight (noticing that you can't refract light from almost all regular light bulbs)
2. If there's no sunlight, an investigation can be done to 'put the rainbow back together', by mixing the different filtered torch lights (green, blue and red). These three colours, known as the primary colours of light, will look white when all put together.
3. Because torchlight can give fuzzy edges, try having some paper with a hole cut in it, so students can look at only a small area at a time. It makes it easier to distinguish the various colours.



The primary colours of light are red, green and blue. When put together, they look like the image above.

This picture shows what it looks like when the primary colours of light are put together

Year 1: Where the wild things grow

Leaves like light

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Students recall how leaves like light, especially rainbow light. But why do the leaves like light? How can you tell? And which ones grow, survive and thrive best in the environment? This lesson investigates.

This lesson comes in two parts. This first is a display of leaves photosynthesising in a watery solution so they can see where photosynthesis is happening. Then students will measure the surface area of leaves so the students can start to make their own connections between leaf size and its capacity to photosynthesise.

Part 1: Bubbling photosynthesis

Teacher information

As plants photosynthesise, the oxygen generally isn't visible as it comes out. Placing a photosynthesising leaf in a liquid solution that includes dishwashing liquid (to make it easier for the air to come out) and sodium bicarbonate (to give the plant a carbon source in lieu of carbon dioxide), both gives the plant the carbon source it needs to photosynthesise, and also allows the students to see the oxygen, as air bubbles, as the float out of the leaf.

Learning outcomes

Students will be able to:

- see oxygen coming out of a photosynthesising plant.
- discuss and predict what will happen in their experiment.
- become familiar with the scientific method.
- draw connections between leaves liking light, and leaves actually using that light to photosynthesise.
- practice counting.
- compare the size of their leaves. Leaves can be ordered from smallest to largest for additional curriculum outcome achievement.

Materials

- 1/8 teaspoon Sodium bicarbonate (Baking soda)
- 1 drop dishwashing liquid
- 300ml water
- 2 (or 3) x weeds or leaves per experiment, pulled fresh from the ground, preferably on a sunny day. Weeping willow works well, as does paspalum, and some native grasses.
- Clear container (one per experiment)
- Sunlight or a lightbulb suitable for hydroponic growth

Instructions

1. Prepare the solution for each trial by mixing:
   - 1/8 teaspoon baking soda
   - 300ml distilled or cooled, pre-boiled water
   - 1 drop dishwashing liquid
2. Place the solution into a glass or clear acrylic/plastic container.
3. Place the freshly picked weed or leaves into the solution.
4. Place the weed and solution into sunlight
5. Watch the bubbles as they float to the surface
6. Ask students what they can see.

The bicarbonate is a source of carbon for photosynthesis. The dishwashing liquid wets the waxy surface of the leaf allowing the oxygen a freer path to escape. The solution can't be made in advance, because the sodium bicarbonate will escape from the solution as carbon dioxide over time.

This picture shows oxygen being produced by a photosynthesising native grass

Year 1: Where the wild things grow

Leaves like light

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Students recall how leaves like light, especially rainbow light. But why do the leaves like light? How can you tell? And which ones grow, survive and thrive best in the environment? This lesson investigates.

Part 2: Counting leaf squares

Teacher information

The students have seen that leaves are where photosynthesis happens in the previous display. Things live in different places where their needs are met. Plants need to live where their leaves can absorb light energy from the sun. Large leaves often have the ability to collect more light (although there are many variables in what makes an efficient plant). Students will measure the area of a range of leaves to compare and discuss how much light each would be able to absorb.

Learning outcomes

Students will be able to:

- draw connections between leaves liking light, and leaves actually using that light to photosynthesise.
- practice counting.
- compare the size of their leaves. Leaves can be ordered from smallest to largest for additional curriculum outcome achievement.

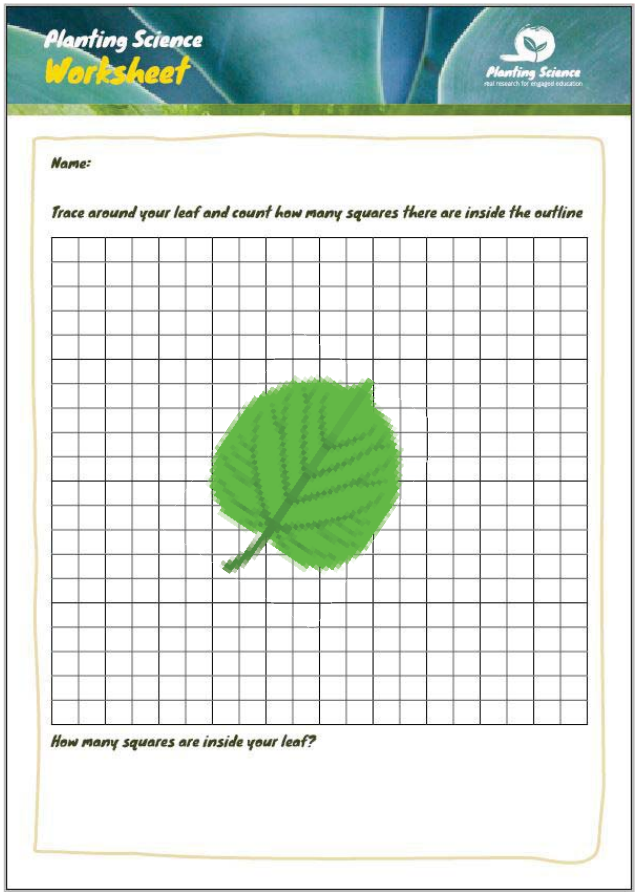
Materials

- pencil
- one or two leaves per student
- grid paper/worksheet

Instructions

1. Students will trace around their leaf on the grid paper provided. They'll then count the squares to see which is the largest. The bigger the leaf, the greater capacity the leaf will have to photosynthesise, grow and survive in the environment.

2. What would happen if another plant grew on top of a smaller plant, shading it from the sun? Plants will often stretch out their stems or branches to reach for the light, because plants live where their needs are met, and plants need light to survive.



Year 1: Where the wild things grow

Word play

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Students play a game of dominoes where they match up a picture to the written word.

Learning outcomes

For students to become familiar with some of the language around plants.

Materials

- printed domino game, 1 per group.

Instructions

1. Ask the students if they know what the words in the game of dominoes are.

2. Come up with a class definition for each, if they're not sure of the meaning. The words are:

- Air
- Fruit
- Leaf
- Plant
- Roots
- Seed
- Stem
- Sun
- Vegetable
- Water

3. Students get into groups of 4.

4. Have the game printed and ready to play.

5. Students match up the word to the picture, the word with the word, or the picture with the picture.

Dominoes.

Where do the wild things grow?

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Students have seen that leaves like light. But what if a plant is grown in the shade? How far will it go to grow?

Teacher information

This experiment shows how plants can change and adapt to their environment to make sure their needs are met. Plants will seek the sun where they are planted.

The bean plant will need 4-5 days to show the sun seeking growth as it reaches up to the sunlight.

Keep the experiment for the following lesson.

Learning outcomes

Students will be able to:

- use the scientific method as a class

Materials

- scientific method worksheet
- shoebox
- extra cardboard
- scissors
- tape
- small potted bean plant

Instructions

1. Cut a hole at one small end of the shoebox, to let some light in.
2. Cut two pieces of cardboard, that are about half the width of the shoebox, but the same height as the shoebox, as shown.
3. Tape both pieces of cardboard into the shoebox as shown, to create a maze for the plant to growth through
4. Place the small potted plant in the shoebox opposite to the hole. Make sure it's well watered.
5. Close the box, tape it together and place it on a sunny windowsill.
6. In 4 or 5 days, open the box and notice how the plant grows in the direction of the light coming down from the hole.
7. This experiment shows that plants grow to live in places where their needs are met. Plants are different to animals (including people), in that they can't walk around and move like animals do. They have to find ways to live where they are planted.

Bean seedlings in a plant maze. Another cardboard panel will be placed on the front so it's light sealed.

Note: The larger the maze, the longer it will take to see results. A shoebox is a good sized box for this experiment.

Year 1: Where the wild things grow

Draw your conclusion

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Students will observe the changes in their plant, discuss the results and draw their conclusion.

Teacher information

Students will be able to see that the bean plant has grown up around the shoebox maze to make it to the light. Plants will move to places where their needs are met, as much as they're able.

Learning Outcomes

Students will be able to:

- use the scientific method.
- interpret the results to explain what happened in the experiment.

Materials

- plant maze experiment from previous lesson
- worksheet

Instructions

1. Students will open up the planter boxes to reveal how their plant has grown.
2. What do they notice?
3. Students draw their conclusion together with a short sentence using words from the word wall.

Science Snapshot
Lily Chen

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Meet Lily Chen. Lily works to see how sugars are transported in plants.

Meet Lily Chen.

Lily works at the Australian National University. She likes science because she gets to discover things that no one else has ever known about.

A bit about Lily's research

The research Centre Lily works for (the ARC Centre of Excellence for Translational Photosynthesis) works to increase photosynthesis, to translate to higher crop yields for farmers.

One of the barriers to increasing photosynthesis is the plants own sugar movement and storage mechanism.

There's a pipeline from where the plant makes sugar (in the leaf), to where it stores it (in the stem). The plant is made of millions of cells that connect different parts of the plant and these cells have a thin film called a membrane between cells. There are special molecules that transport the sugar across this membrane.

Lily is working to figure out how those transporters work, in the hope that transportation might happen quicker, allowing more sugar to be made in the leaf.

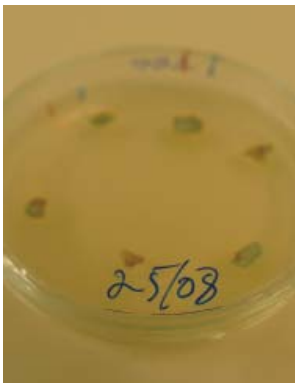
More about Lily

Lily decided she wanted to be a scientist because she wanted make a meaningful contribution to the world and our understanding of it.

She finds the most exciting thing about being a scientist is being able to meet so many different people from all around the world and having people push you to do your best.

The worst thing is when things don't go to plan.

Lily also likes reading, watching tv shows and films and trying new foods.



Lily is pictured left as an artwork is made of her research. On the right are tiny plants being grown in gel.

This is an artists impression of Lily's work. It was created by Jessie Marshall as a part of Science Week activities for a project called 'Street Art Meets Science'.

It was a co-LAB-oration.

Year 1: Where the wild things grow

Curriculum outcomes and teacher information

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Type of lesson	Lesson	Short description	Delivery	Science outcomes	Literacy Outcomes	Maths Outcomes
Engage	**Where the wild things grow**	In the book 'Where the wild things are', there's a forest growing in Max's room. Would a forest be able to grow inside? Students investigate.	Observation and experiment	Living things live where their needs are met, ACSSU211, Science involves observing, asking, describing changes, ACSHE021	Engage in conversations and discussions, ACELY1656	
Optional Inclusion	**Science Snapshot**	Meet Min Chen. Min discovered a special kind of chlorophyll that photosynthesises in very low light conditions.		Living things live where their needs are met, ACSSU211, People use science in their daily lives, including when caring for their environment, ACSHE022		
Explore	**Leaves like light**	In this interactive display of bubbling photosynthesis, students will be able to see why leaves like light. They'll also measure some leaves for themselves. Which one will grow best? Bigger or smaller?	Observation	Living things have a variety of external features, ACSSU017 Science involves observing, asking, describing changes, ACSHE021, Pose questions, make predictions, ACSIS024, Compare observations with others, ACSIS213		Develop confidence with number sequences, ACMNA012, Measure and compare using uniform informal units, ACMMG019
Explain	**Word play**	Students play a game of dominoes where they match up the plant part picture to the written word.		Living things have a variety of external features, ACSSU017	Engage in conversations and discussions, ACELY1656, Use interaction skills including turn-taking, ACELY1788	

Year 1: Where the wild things grow

Curriculum outcomes and teacher information

Planting Science
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Type of lesson	Lesson	Short description	Delivery	Science outcomes	Literacy Outcomes	Maths Outcomes
Elaborate	**Where do the wild things grow?**	Students have seen that leaves like light. But what if a plant is grown in the shade? How far will it go to grow?	Interactive experiment	Living things live where their needs are met, ACSSU211 Science involves observing, asking, describing changes, ACSHE021, Pose questions, make predictions, ACSIS024, Participate in guided investigations, ACSIS025		
Evaluate	**Draw your conclusion**	Students have conducted their own experiment, now they'll need to discuss their results and draw their conclu-sion	Whole class discussion and individual activity	Living things have a variety of external features, ACSSU017, Living things live where their needs are met, ACSSU211 Science involves observing, asking, describing changes, ACSHE021, Pose questions, make predictions, ACSIS024, Use informal measurements to record observations, ACSIS026 Participate in guided investigations, ACSIS025 Use a range of methods to sort information, including drawings, ACSIS027, Compare observations with others, ACSIS213,	Engage in conversations and discussions, ACELY1656	
Optional Inclusion	**Science Snapshot**	Meet Lily Chen. She works to understand how sugar transportation happens in plants. It's hoped that this information will be used to maximise photosynthesis in the worlds major crop plants.		People use science in their daily lives, including when caring for their environment, ACSHE022		

Year 1: Where the wild things grow

Materials

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What you will need

Lesson	Materials required
Where the wild things grow	• book: Where the wild things are • whiteboard/large piece of paper to write on • marker • light refracting prisms, magnifying glasses, glasses of water, crystals etc. • several table lamps with regular light bulbs (these can be any light or LED) • sunlight if available, or, • 3 torches with coloured filters on them, one red, one blue and one green • optional, for use with torches, paper with holes punched out of it (using a hole punch), so students can only look at small parts of the shining coloured light at a time
Leaves like light	• 1/8 teaspoon Sodium bicarbonate (Baking soda) • 1 drop dishwashing liquid • 300ml water • 2 (or 3) x weeds or leaves per experiment, pulled fresh from the ground, preferably on a sunny day. Weeping willow works well, as does paspalum, and some native grasses. • clear container (one per experiment) • sunlight • pencil • one or two leaves per student • grid paper/worksheet
Word play	• printed domino game, 1 per 4 students.
Where do the wild things grow	• scientific method worksheet • shoebox • extra cardboard • scissors • tape • small potted bean plant
Draw your conclusion	• previously planted plant maze experiment • worksheet