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

Planting Science

Year 5

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Year 5: Structural Features and Stems for Survival

Unit at a glance

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Living things have structural features and adaptations to help them survive in the environment, but how does it work in real life? This unit investigates.

1 What weight is that?

Short introduction on the technique of how to use scales.

2 STEM Stems

Students are challenged to raise a book off a table using only an A4 piece of paper and one piece of tape.

Science Snapshot: Graham Farquhar gets more wheat for your water by using cross breeding techniques.

3 Survival

Students play a game of survival where they are the plants. See who can make it through to adaptation!!

Science snapshot: Rob Sharwood works to improve crop yields in a changing environment.

4 Find the words

Students create a plant adaptation crossword puzzle.

Science Snapshot: Meisha Holloway-Phillips counts carbon and nitrogen molecules to see how efficient plants are.

5 Succulent stems

Students start their own experiment by collecting leaves from plants, which they'll weigh and then place in a food dehydrator.

6 Dry weight measurement

Students weigh the samples after they've been dried and using a simple minus calculation, figure out the water weight of the sample.

Optional inclusions and notes

Use a microscope
Students practise using a microscope.

Spot the stomata
Students make simple leaf peel slides and spot the stomata under a micrscope .

Science snapshot:
Florence Danila uses a microscope and light to capture amazing images of what's happening inside leaves.

Curriculum links & learning outcomes
Teacher information included in a table at the end of this document.

Year 5

Structural Features and Stems for Survival

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This unit aims to achieve multiple curriculum outcomes using real research in the classroom for easy engagement.

About this unit

This unit makes understanding survival and adaptation easy. It uses games and interactive activities to show how these concepts work over time in the real world. Students will also use real research techniques to conduct their own research study different kinds of plants.

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

Year 5: Structural features and stems for survival

What weight is that?

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To become familiar with measuring weight, students will use scales to weigh different objects, after guessing which is heavier or lighter.

Teacher information

This lesson takes inspiration from this video, created by the BBC, and distributed by ABC Splash http://splash.abc.net.au/home#!/media/1423715/illusion-of-size-and-weight.

Students will weigh a range of objects, some which are small and dense, some that are large and relatively light. The brain often tricks us into thinking small things are heavier than they really are, making it hard to guess which object is heavier.

There is an opportunity to elaborate on Mathematics curriculum outcome ACMMG108 (Choose appropriate units of measurement for length), in particular elaboration 'investigating alternative measures of scale to demonstrate that these vary between countries and change over time'. The people in the video guess the weight of different objects, and some guess in kilograms, and some in pounds.

Learning Outcomes

Students will be able to:

- use scales to measure weight.
- record the results.

Materials

A range of objects, some which are small and dense, some that are large and relatively light.

Some objects to weigh together might be:

- large teddy bear and a small wooden car
- russian dolls, large empty and a smaller doll with another doll inside
- a pillow and a book
- scales

Instructions

1. Ask the students which of the pairs will be heavier or lighter.
2. Explain that they'll be measuring the weight of the objects to find out.
3. Ask the students what unit of measurement they'll use to record the weights.
4. Demonstrate how the scales work, and how to read the number on the scale.
5. Ask students to hold the objects and guess what the weights are.
6. Show students this short video explaining why they got the results they did.

Year 5: Structural features and stems for survival

STEM Stems

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Students are challenged to raise a book at least 10 cm off the table, using only one piece of A4 paper and one piece of tape.

Teacher information

Students will figure out that a cylinder structure will hold the book up. They'll then be challenged to play around with the structure so they can hold as much weight as possible on their cylinder.

An extension activity might be to observe real stems either with a magnifying glass or microscope, or just by looking closely. You'll notice the stem structure is made from a lot of small cylinders encased in one larger cylinder. The small cylinder's transport water, sugars and nutrients around the plant and also give the stem a strong structure.

Learning Outcomes

Students will be able to:

- use critical thinking to solve the paper problem.
- see that different shapes will hold different weights.

Materials

- paper
- sticky tape
- scales
- books to use as weights

Paper holding weight.

Instructions

1. Ask the students to produce a structure using only one piece of paper, and one piece of tape, that will hold up a book or other weight. If they need help, they can look to nature for inspiration and see if they can think of a small (thin) structure that holds up a heavy weight (a stem to a flower).

2. Once they've realised the cylindrical structure will hold up the book, they can start the investigation. Ask the group how they think they can make the strongest structure.

3. Students will test whether the following structures will hold the most weight:

- wide cylinder,
- narrow cylinder or
- lot of small cylinders held together with a wide cylinder

4. Ask the students how they'll best represent the data so it's easy to read the results. Ask them to draw up their graph or table, ready for recording their results

5. See how much weight they can put on their structure. You'll need many books or weights to test the structures.

6. Once each group has tested their structure, they can bring the results to the teacher, who will compare the weights held

7. Once the students have experimented, discuss the results as a class.

8. Review the results of the class graph together and discuss. The final learning outcome will be.

- One narrow cylinder will hold some weight.
- One wide cylinder will hold more weight than the narrow cylinder.
- Many narrow cylinders together will hold a lot of weight.

Three different kinds of cylinders that will hold weight.

Year 5: Structural features and stems for survival

STEM Stems

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Students are challenged to raise a book at least 10 cm off the table, using only one piece of A4 paper and one piece of tape.

Additional teacher information

These are celery stems growing in the ground, and cut as a cross section. The cylinders within the stems hold the weight of the plant, and act as transport for water coming up from the ground, and transporting sugar created in the leaf during photosynthesis, to other parts of the plant.

The cut cross section shows the cylinders around the outside of the stalk, they are the 'xylem', which are responsible for transporting water up from the ground.

Cylinders are also able to carry heavy weights, like this sunflower.

As an extension activity, you could have a piece of celery and a sunflower available to hands on investigation.

Celery growing in the ground.

This sunflower stem is holding a lot of weight!

The cylinders on the outside of the stalk are the 'xylem', they carry water up from the roots.

Science Snapshot

Graham Farquhar

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Meet Graham Farquhar, he's working to get more wheat for your water in a changing climate.

Meet Graham Farquhar.

Graham was a curious kid, always asking lots of questions to his parents. His Dad worked in Tasmania with the Department of Agriculture communicating research from the lab to the farmers. Graham says he could see the value in his Dad's work, and how well the results were working for farmers.

When he was 14, Graham's Dad gave him a book that he'd brought back from America, called Biophysics. At the time, he didn't know what it was about, but on advice from one of Australia's leading biophysicists Ralph Slatyer, Graham set about to learn maths and physics, and to use that knowledge in biology. And that's what he's spent his career doing.

A bit about Grahams research

One of the discoveries Graham's made, in collaboration with Dr Marion O'Leary and Dr Joe Berry, is in being able to predict how water efficient a plant is, by testing for different types of carbon atoms in the plants molecular make up.

When a leaf's stomata are open, the number of different carbon atoms are about the same ratios as you'd find in the atmosphere.

Plants that have stomata that are often closed are more water efficient because not much water can escape.

These water efficient plants don't release the different carbon atoms as much as the plants with open stomata, so the concentration of different carbon atoms in water efficient plants is higher.

All matter is made up of smaller particles, called molecules.

Molecules are made up of even smaller parts, called atoms.

Did you know there are different kinds of atoms that are interchangeable? They're the same because they have the same number of protons. They're different because they have a different number of neutrons.

These different types of atoms are called isotopes. Some isotopes are unstable and radioactive.

Others are stable and not radioactive. These stable isotopes can be counted by a scientific machine called a 'mass spectrometer'.

Science Snapshot

Science Snapshot
Graham Farquhar

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In a project led by Dr Richard Richards from CSIRO (which stands for the Commonwealth Scientific and Industrial Research Organisation), this discovery led to the production of two new varieties of wheat, called Drysdale and Lees (named after Australian landscape artists Russell Drysdale and Lloyd Rees). This work was also achieved as a result of a collaboration – a scientific team – including several scientists from the CSIRO (pictured below) with Graham at the Australian National University.

Teamwork and collaborations are really important to making new discoveries and achieving seemingly insurmountable goals.

Graham has become internationally renowned for his mathematical modelling and work on improving crop yields for farmers. Graham was awarded the prestigious Prime Ministers Prize for science in 2015, and the Kyoto Prize (known as being biology's answer to the Nobel Prize) in 2017. He's also a Fellow of the Royal Society, the world's longest running and most prestigious scientific society.

A little bit more about Graham.

What do you like to do your spare time?

I enjoy Australian Rules football, which I played a bit of at Wesley College, then at ANU and briefly in Queensland. I am interested in politics though largely in the sense of wanting to be a well-informed voter. I am of course interested in my own and my extended family. But the main outside interest has been ballet, dance and dance theatre. I started learning dance in 1970 when I started my PhD. In 1973 I gave a dedicated copy of my thesis to my ballet teachers, Bryan Lawrence and Janet Karin. I started a dance group at the University (the National University Dance Ensemble), and that later developed into the Canberra Dance Ensemble and then the Canberra Dance Theatre. I organized the dance programme for a Festival of University Arts, involving dance groups from around Australia and performed in a mime piece myself. In East Lansing I danced with the MSU Orchesis group, and also the Lansing Ballet. In 1974 I went to New York City and started taking classes there for a couple of weeks, but recognized that as a dancer, I made a wonderful plant biophysicist. I was just lucky that males at that time had many more opportunities in dance than males have today, or than women had then and now.

What is the most important thing in your life?

To me the most important things are to struggle to improve, to struggle to be honest, to struggle to re-evaluate one's prejudices. But I also love being with friends and family, and I love sensations coming from the body moving properly or watching the night sky in Burra on a clear night, or sitting in front of a wood fire, or eating quality dark chocolate, or examining a brilliant wild-flower in the bush, or watching echidnas, wombats, wallabies and kangaroos on our land.

More information on Graham here: https://www.youtube.com/watch?v=dlyXFgWmfjM From Prime Ministers Prize for Science

And here:

http://www.anu.edu.au/news/all-news/anu-scientist-graham-farquhar-first-australian-to-win-kyoto-prize From Kyoto Prize

Christopher Pyne, Minister for Industry, Innovations and Science (left) and Prime Minister Malcolm Turnbull (right) pictured with Graham as he accepts the Prime Ministers Prize for Science.

From left, Richard Richards, Graham Farquhar, Greg Rebetzke and Tony Condon, examining different wheat lines.

Year 5: Structural features and stems for survival

Survival

Students play a game of survival where they are the plants.. See who can make it through to adaptation!!

Teacher information

Adaptation can be broken down into five steps abbrieviated to **V.I.S.T.A.:**

Variation — small differences between traits.

Inheritance — different traits are passed on to offspring.

Selection — when a plants traits don't allow it to survive in an environment.

Time — when plants die because they can't survive an environment.

Adaptation — Adaptations are differences in traits that have been selected for (i.e. haven't died) in a population.

Learning outcomes

Students will be able to:

- understand how adaptations work in populations.

Materials

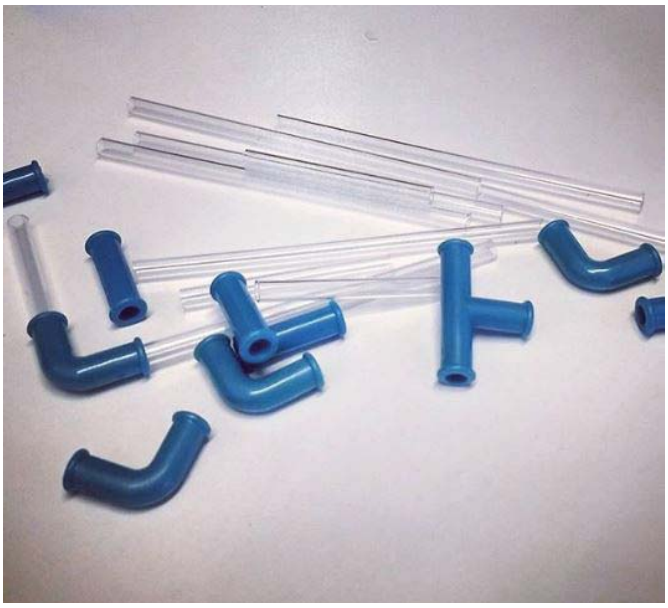
- straws
- disposable cups
- straw connectors

Instructions

Like plants, students will have a natural variation in the height that they're able to draw water through a straw or stem. In this game, students test out their abilities.

Depending on the class, this game might work best outdoors on a warm day. Provide some pre-activity information on how to play Survival hygenically, by not swapping straws or cups.

1. Students are given disposable cups and clear straws.
2. In pairs, students take turns in drawing water through the straws. After each successful draw, they'll add another length of straw.
3. Graph each students draw.
4. The highest nimber of straws will likely be able to survive better than the others because:
   - The tallest trees can reach up through a dense canopy so they don't have to compete for light resources, and
   - Long roots will be able to reach down to collect ground water in period of low rainfall.
5. The tallest straw-drawers will be able to survive and thrive better than their peers. This may also mean they'll be better able to reproduce.
6. The tall-drawer trait may be passed down to any resulting offspring, making them also better able to survive. Over time, the shorter-drawers may be selcted out of the population (i.e. not reproduce or die due to not being able to grow tall enough). This would make most of hte population tall-drawers. This would then be an adaptation of the population.



Connector straws

Science Snapshot
Rob Sharwood

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Meet Rob Sharwood: a rising star researcher looking to secure food sources under changing weather conditions.

Meet Rob Sharwood

Rob studied at the Australian National University for a degree in molecular biology and biochemistry. He was particularly interested in plant science and wanted his career to stay close to his family's farming roots. Not knowing what to do over summer he asked if there were any summer research projects available at plant science within ANU. He found a project he found appealing, investigating Rubisco, and from there his research career was born.

Currently, Rob's working on improving crop productivity in widely used crops: rice, wheat, corn, canola and cotton

A bit about Rob's research

Overall Rob's main interest is to improve crop yield in rice, wheat, corn, canola and cotton through discovering new solutions for plants to cope with climate change. His current projects include:

- Improving photosynthesis of Eucalyptus trees so they can cope with future extreme climates.
- Improving cotton productivity to by finding natural variation within varieties and species.
- Trying to understand how chloroplasts are created within the leaf and how they interact with other parts of the plant cell, which is important for genetically making better chloroplasts.
- Exploring natural variation in how Rubisco works in blue green algae (which is different to most algae because it's a bacteria that can photosynthesise), other algae and C_4 plants (like corn, which grow quicker than non-C_4 plants) and;
- Changing DNA to make Rubisco's better suited to future climates.

More about Rob

What do you see as challenges for your field of research?

Some challenges include research grants for basic science, interacting with industry and longevity of academic positions.

What do you enjoy most about research?

Four things I enjoy most are, interactions with farmers, collaborations - I have many national and international. collaborations on exciting projects, generating new solutions to improve crop productivity and making discoveries to advance my field

Who are your science heros?

Rosalind Franklin, Graham Farquhar, Susanne von Caemmerer and Andrew Benson.

What else do you have underway?

Competing in Ironman Teams events!

Rubisco is a very important protein molecule.

It's an enzyme – which means it starts the chemical reaction.

It's the enzyme responsible for kick starting photosynthesis.

Without it, there would be no photosynthesis, no oxygen to breath, and no food to eat.

Rob in the lab.

Science Snapshot

Year 5: Structural features and stems for survival

Find the words

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Students create a plant adaptation crossword puzzle, using an online crossword generator, and their own words and descriptions.

Teacher information

Students discuss and decide on the key words associated with what they've seen happening in their experiments. They'll need to include these key words in a crossword that they'll make using their own descriptions either online, or on the worksheets provided. If they've got time they can play each other's games or challenge their parents with them!

Learning outcomes

Students will be able to:

- identify the words to describe what they're seeing.
- come up with descriptions for key words in the survival/ adaptation conversation.
- demonstrate their understanding of the concepts in an informal process.

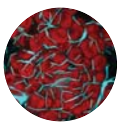
Materials

If creating the crossword online, go here https://worksheets.theteacherscorner.net/make-your-own/crossword/

Or you can make a crossword in Excel, instructions here: https://www.youtube.com/watch?v=363Y1i4MQYo

Or you can make your crosswords with regular pencil and paper, using the worksheet provided.

Instructions are provided on the worksheet.



Year 5: Structural features and stems for survival

Succulent Stems

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Students collect leaves from a plant, making sure some are from a succulent, which they'll weigh and then place in a food dehydrator, or taken away to be dried in an oven.

Teacher information

Succulents live primarily in arid environments like deserts with high temperatures and low rainfall. Nearly all cacti are succulents but not all succulents are cacti. Succulents have adapted over many generations to retain water, most store water in their stems, but some have adapted leaves or root systems.

Learning outcomes

Students will be able to:

- compare and differentiate between succulent and non-succulent plants.
- be familiar with some of the language around fair tests and the scientific method.
- extend their understanding of what structural adaptations are, and how they work for plants in the physical environment.

Materials

- leaves
- disposable, oven proof dishes (possibly foil, or disposable pie/cupcake tins – disposable pie tins with lids would work well because the lids could be used for labelling once dried)
- oven or food dehydrator

Instructions

Pre-class preparation

The leaves can be picked on a walk in the school yard if the school has a range of plants available to be picked. Alternatively, leaves can be brought in for students or students can pick some leaves from home (make sure to ask parents first!).

Introduction

1. Ask the students if they think all plants hold the same amount of water inside them.
2. If they look at the leaves collected, do they think some will have more water in them than others? How would they test that scientifically?
3. The students can use the scientific method worksheet as a guide to making a fair test.
4. The one variable in this instance, will be the plant type.
5. The method will be based on using weight as a measurement.
6. They'll realise that they can work out how much water is in a plant/leaf/stem by measuring the fresh sample, then drying it, then weighing it again with all the water dried out of it.

Experiment

1. Students will pick 5 or 6 leaves each, either from home or the school yard.
2. Make sure there are a number of succulents or cacti in each students selection
3. Students will be given a small disposable oven-safe dish for each different species of leaves. They'll have to label their sample pot with:
4. Their name/initials
5. The fresh weight (i.e. the pre-dried weight)
6. The sample then needs to be contained in an oven proof vessel so the contents don't spill out during transportation (although when drying the sample, the containers can't be completely sealed so the water can evaporate out)
7. The samples are then dried either on a food dehydrator or in a very low heat oven.
8. Results will be collected and graphed after drying the samples

Succulent leaves.

Non-succulent leaves.

Year 5: Structural features and stems for survival

Dry weight measurement

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Students complete the dry weight experiment by using real research techniques.

Teacher information

Students have already labelled and weighed their samples before drying. In this lesson, students will weigh their samples after they've dried, and complete a simple subtraction calculation to figure out how much water the sample held before drying.

Learning outcomes

Students will be able to:

- use maths skills and learn how they're used in real research examples

Materials

- previously dried leaf samples
- scales that measure down to 0.1g
- unit worksheet

Instructions

1. The Excel worksheet provided is designed to automatically calculate what the water weight is for each sample and to graph it as a column graph. Students can also do this calculation and display themselves
2. Do all samples hold the same percentage of water?
3. Ask them some questions about where they think each sample would be able to survive and why
4. Is the ability to hold water an adaptation? Ask students to discuss their sample results with a friend, and using the words and descriptions from the previously made crossword puzzle, write a few sentences about what happened and why.

Succulent leaves before drying.

The same succulent leaves after drying.

Science Snapshot
Meisha Holloway-Phillips

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Meet Meisha Holloway-Phillips. She measures plant biomass to see how well plants are photosynthesising.

Meet Meisha Holloway-Phillips.

Meisha finds plants fascinating. She's interested in how photosynthesis works, especially how light is absorbed by the leaf, how carbon is converted from carbon dioxide into carbon in the sugar molecule using the energy of the absorbed light, and how these processes interact with each other.

A bit about Meisha's research

One of the projects Meisha works on is investigating how eucalypts respond to growing in high carbon dioxide environments.

The way she does that is by measuring and predicting plant biomass. In some studies, Meisha grows many eucalypt plants, with some growing in high carbon dioxide (CO_2) and some in the regular atmosphere. She's testing to see, which plants grow a lot faster at the higher CO_2 concentrations.

It's hoped that by finding out which plants can capture more carbon quicker, we'll know which trees to plant that will grow best at the higher CO_2 concentrations of the future. It might also be a part of the solution of how to reduce the levels of carbon dioxide in the atmosphere, by growing lots of plants that will be able to capture that carbon and turn it into the solid plant structure - wood!

This is Meisha Holloway-Phillips

Seedlings at the start of an experiment.

More about Meisha

Meisha likes science because you get to discover and do things that no one has ever done before.

She decided he wanted to be a scientist because she liked tinkering and figuring out how things work. Now she is trying to figure out how photosynthesis works.

The most exciting thing about being a scientist is working with people from all over the world, from different backgrounds and with different experiences in life.

The worst thing about being a scientist is the uncertainty of where the funding for the next exciting project is going to come from.

Meisha also likes photography and to play ultimate Frisbee.

Carbon dioxide is produced when fossil fuels like coal and oil are burnt, usually for electricity production. Atmospheric CO_2 levels are high and rising since the industrial revolution.

Plants are grown in a glass house so water and atmospheric carbon dioxide can be set and monitored by the researcher.

Science Snapshot

Year 5: Structural features and stems for survival

How to use a microscope

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If you have microscopes available, this lesson sequence can be very exciting for students. This lesson is designed as a brief introduction to using a microscope before actually doing the experiment later.

Learning outcomes

Students will be able to:

- focus a microscope.

Materials

- microscopes
- scrap paper, cut into small pieces
- worksheet

Instructions

1. Have students work in pairs or individually if there are enough microscopes
2. Show students the different parts of the microscope (eye piece, magnification lenses, stage and focus knobs in particular)
3. Give each student a small piece of paper with writing on it
4. Ask the student to turn their magnification lense to show the smallest image, which will be a 4 x magnification.
5. Ask students to use the course focal adjustment to bring the words into focus
6. Show students how to use the fine adjustment to get a clear image.

Year 5: Structural features and stems for survival

Spot the Stomata!!

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Stomata are the small, mouth-like openings on a leaf that lets air in, and excess water out. Students will make simple slides to investigate on a microscope.

Teacher information

Stomata are the small, mouth-like openings on a leaf that lets air in, and excess water out. Whenever plants open their stomata to absorb carbon dioxide, some water is lost. But this works differently for different plants. Stomata are a key piece of the puzzle in trying to figure out how plants can grow best, even in high temperatures and low rainfall.

Learning outcomes

Students are able to:

- see stomata.

Materials

- cellotape (not magic tape, the tape needs to be clear, not opaque to work)
- clear nail polish
- slides
- 5-10 leaves per sample (including succulents). It works well if you've got leftover fresh leaves from the dry weight measurement experiment
- microscope(s)
- worksheet

Instructions

The students have been investigating the stems of plants, and water storage within the plant, but what happens if there's too much water at the leaf than the plant needs? Students may not know that plants have little openings on their leaves called stomata. The stomata can usually only be seen under a microscope, and their task is to find the stomata and count how many there are.

Given what the students know about some plants holding water better than others, do the students think all plants will have the same number of stomata? Students will look at a few different sample slides and count how many stomata there are, to see if there's a difference between different plants, and a difference between how many are on the top and bottom of a leaf (note – not all leaves have a top and bottom, like grasses, and in that instance, this won't apply)

Slides can be made before class to allow students to get straight into the activity.

To prepare slides:

1. Either have students bring leaves into class or go on an outdoor walk to collect some leaves.
2. Make sure there are some succulent leaves available for investigating.
3. Paint a small amount (about 7mm square) of clear nail polish directly onto the leaf
4. The nail polish can take 10-20 minutes to dry depending on how warm it is and how dry the or wet the samples are
5. While the nail polish is drying, label the slides, with the researchers initials, and if the leaf has a top side and an underside, students will label slides with top and underside.
6. Once the nail polish is dry, stick the cellotape directly onto the dried nail polish and press firmly.
7. Rip the tape off in one go, which will take the nail polish and an imprint of the leaf with it.
8. Stick the tape and nail polish onto the labelled slide.
9. The slide is now ready to investigate.

A microscope slide prepared using clear nail polish, applied to the leaf, dried, sticky tape placed over the dried nail polish, then ripped off, and stuck to a glass slide.

Year 5: Structural features and stems for survival

Spot the Stomata!!

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Stomata are the small, mouth-like openings on a leaf that lets air in, and excess water out. Students will make simple slides to investigate on a microscope.

Find the Stomata

1. Recap on how to focus a microscope
2. Place the slide on the stage
3. Set at 4 x magnification
4. Set the course adjustment
5. Set the fine adjustment
6. Move to 10 x magnification
7. Reset the fine adjustment (the course adjustment should be fine)
8. Students investigate several samples and count how many stomata they're able to find at 10 x magnification for each sample
9. Samples are recorded centrally by the teacher so results can be compared across the whole classes samples
10. Images below show stomata at 4 x and 10 x magnification. The stomata are circled in yellow.

Stomata under a microscope shown at 4 x magnification, circled in yellow.

Stomata under a microscope shown at 10 x magnification, circled in yellow.

Science Snapshot

Florence Danila

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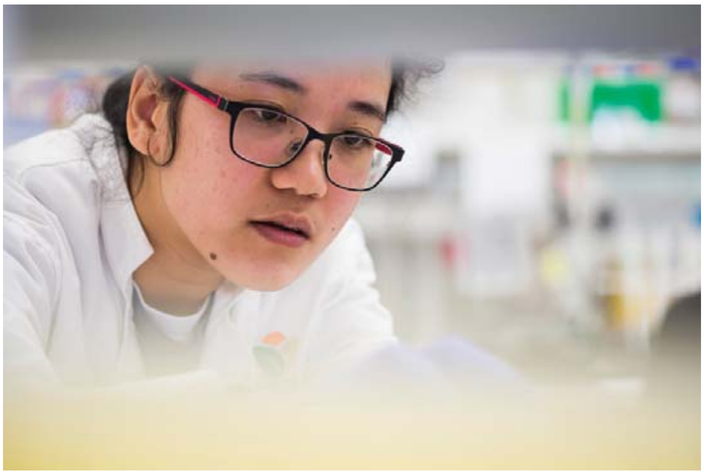
Florence uses a microscope, and light to see what's going on inside plants, with beautiful results.

Meet Florence Danila

Florence (also known as Flor) sees things other people might miss. During her studies she figured out a new way to look at leaves.



Flor working in the lab.

A bit about Flor's research

Flor researches the way things move inside plants. She investigates the transport channels and compares them between different plants. She's found that there's a big difference in how many transport channels different plants have. The more transport channels plants have, the quicker they can move things around. Often the plants with the most transport channels are the most efficient in growing and photosynthesising.

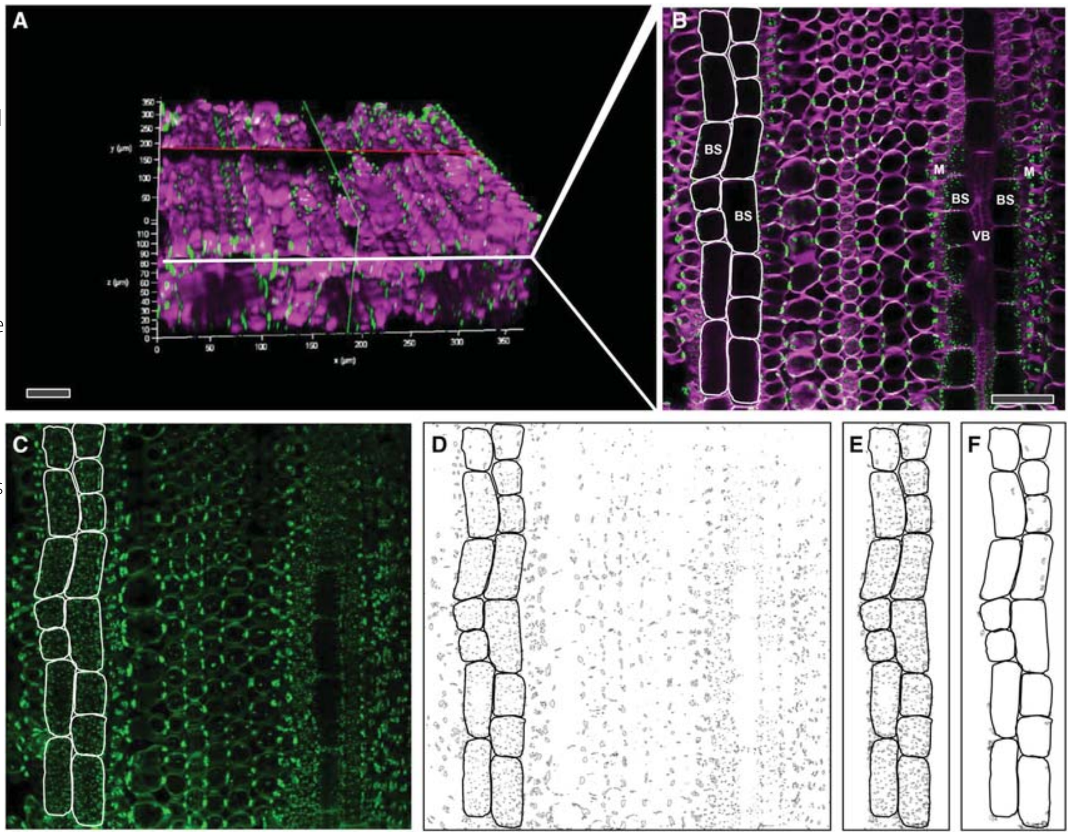
The beautiful part of her work is in how she counts the transport channels. She's devised a way of combining scanning electron microscopy (SEM) and three dimensional (3D) immunolocalisation using confocal microscopy.

But what does that all mean? Descriptions below:

Scanning Electron Microscopy: a beam of electrons are aimed at the sample. The electrons scan the surface and produce information about the samples composition and topography.

Three dimensional (3D) immunolocalisation: This identifies molecules and their locations.

Confocal microscopy: Allows the researcher to lok very closely at a sample. It reduces image 'noise' seeing the sample through a pinhole. A numebr of images are taken and layered together to provide a 3D image.



This is what some of Flor's images look like. They show the transport channels in 2D and 3D.

Science Snapshot

Year 5: Structural features and stems for survival

Curriculum outcomes and teacher information

Planting Science
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Type of lesson	Lesson	Short description	Delivery	Science outcomes	Literacy Outcomes	Maths Outcomes
Optional Lesson	**What weight is that?**	Short introduction on the technique of how to use scales	Quick hit, interactive activity	Students gather data to support predictions, ACSHE081	Understand the use of vocabulary to express greater precision, ACELA1512	
Engage	**STEM stems**	Students are challenged to raise a book at least 10 cm off the table, using only one piece of A4 paper and one piece of tape. They'll find that a cylinder will hold the book up. They're then challenged to construct another structure that will hold more weight.	Small group work, whole class activity	Living things have structural features and adaptations, ACSSU043		
Explore	**Survival**	Students play a game of survival where they are the plants. See who can make it through to adaptation!!	Small group, interactive activity	Living things have structural features and adaptations that help them to survive in their environment, ACSSU043		
Optional Inclusion: Science Snapshot	**Carbon collection in a changing climate**	Meet Rob Sharwood: a rising star researcher looking to secure food sources under changing weather conditions		Scientific knowledge is used to solve problems and inform personal and community decisions, ACSHE083	Clarify understanding of content as it unfolds, ACELY1699	
Explain	**Find the words**	Students create a plant adaptation crossword puzzle, using an online crossword generator, and their own words and descriptions.	Individual work			

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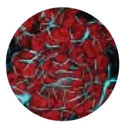
Optional Inclusion: Science Snapshot	**More wheat for your water**	Meet Graham Farquhar, world renowned photosynthesis researcher. He's working to get more wheat for your water.		Scientific knowledge is used to solve problems and inform personal and community decisions, ACSHE083		
Elaborate	**Succulent stems and the scientific method**	Students collect leaves from a plant, which they'll weigh and then dry. Students measure the weight of the samples.	Field work and experiment preparation	Students are guided to plan and write their own scientific investigation, ACSIS231, ACSIS086		Pose questions and collect data observed ACMSP118
Optional Inclusion: Science Snapshot	**Light up your life!!**	Meet Florence Danila, she uses a microscope and light to see what's happening inside leaves.		Scientific knowledge is used to solve problems and inform personal and community decisions, ACSHE083		
Evaluate	**Dry weight measurement and results**	Students weigh the leaf samples after they've been dried and using a simple minus calculation, figure out the water weight of the initial sample.	Interactive activity individually or in small groups	Construct and use a range of representations, including tables and graphs, ACSIS090, ACSIS218, ACSIS093	Use interaction skills appropriate for different audiences and purposes ACELY1796 Use comprehension strategies to analyse information, ACELY1703	Construct displays, with and without the use of digital technologies ACMSP119



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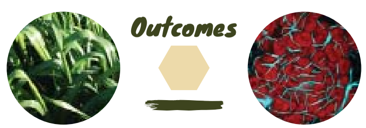
Type of lesson	Lesson	Short description	Delivery	Science outcomes	Literacy Outcomes	Maths Outcomes
Optional Inclusion	**Use a microscope**	Students practice focusing and using a microscope on everyday objects.	Interactive activity individually or in small groups		Students understand the different parts of the microscope, ACELA1512	Pose questions and collect data observed, ACMSP118
Optional Inclusion: Science Snapshot	**What's stomata!?**	Meet John Evans. John finds civersity in the tiny, mouth like openings plants have to let air in and excess water out.		Scientific knowledge is used to solve problems and inform personal and community decisions, ACSHE083		
Optional Inclusion	**Spot the stomata**	Stomata are small mouth-like openings on a leaf that lets air in, and water out. Students hypothesise which leaves will have the most stomata, using knowledge gleaned from the earlier experiments. They test their hypothesis by counting how many stomata there are on the different leaves.		Living things have structural features and adaptations that help them to survive in their environment, ACSSU043 Students are guided to plan and write their own scientific investigation, ACSIS231, ACSIS086	Clarify understanding and use language to relay ideas and conclusions, ACELY1796	Students collect and display their results, ACMSP119 Pose questions and collect data observed, ACMSP118



Year 5: Structural features and stems for survival

Materials List

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photosynthesis.org/teachers

Lesson	Materials required
What weight is that?	• scales, various objects to weigh
STEM stems	• paper, sticky tape, scales
How awesome are plants? **How long is a piece of string?**	• string cut into different lengths, one per student
Find the words	• worksheet, pencils
Succulent stems	• leaves • disposable, oven proof dishes (possibly foil, or disposable pie/cupcake tins — disposable pie tins with lids would work well because the lids could be used for labelling, although they'd need to be loosely fitted while in the oven to allow moisture to evaporate efficiently) • oven or food dehydrator • scientific method worksheet
Dry weight measurement	• previously dried leaf samples • scales • scientific method worksheet
Use a microscope	• microscopes • range of everyday objects. Some items that work well: fabric, hair, writing on paper, bark, flowers
Spot the stomata	• with microscope: cellotape (not magic tape, the tape needs to be clear, not opaque to work) • clear nail polish • slides • 5–10 leaves per sample (including succulents). These will be used for both the stomata investigation and the dried weight experiment • microscope(s) • worksheet

Science Snapshot

Meisha Holloway-Phillips

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photosynthesis.org.au/teachers

Meet Meisha Holloway-Phillips. She measures plant biomass to see how well plants are photosynthesising.

Meet Meisha Holloway-Phillips.

Meisha finds plants fascinating. She's interested in how photosynthesis works, especially how light is absorbed by the leaf, how carbon is converted from carbon dioxide into carbon in the sugar molecule using the energy of the absorbed light, and how these processes interact with each other.

A bit about Meisha's research

One of the projects Meisha works on is investigating how eucalypts respond to growing in high carbon dioxide environments.

The way she does that is by measuring and predicting plant biomass. In some studies, Meisha grows many eucalypt plants, with some growing in high carbon dioxide (CO_2) and some in the regular atmosphere. She's testing to see, which plants grow a lot faster at the higher CO_2 concentrations.

It's hoped that by finding out which plants can capture more carbon quicker, we'll know which trees to plant that will grow best at the higher CO_2 concentrations of the future. It might also be a part of the solution of how to reduce the levels of carbon dioxide in the atmosphere, by growing lots of plants that will be able to capture that carbon and turn it into the solid plant structure - wood!

This is Meisha Holloway-Phillips

Seedlings at the start of an experiment.

Carbon dioxide is produced when fossil fuels like coal and oil are burnt, usually for electricity production. Atmospheric CO_2 levels are high and rising since the industrial revolution.

Plants are grown in a glass house so water and atmospheric carbon dioxide can be set and monitored by the researcher.

More about Meisha

Meisha likes science because you get to discover and do things that no one has ever done before.

She decided he wanted to be a scientist because she liked tinkering and figuring out how things work. Now she is trying to figure out how photosynthesis works.

The most exciting thing about being a scientist is working with people from all over the world, from different backgrounds and with different experiences in life.

The worst thing about being a scientist is the uncertainty of where the funding for the next exciting project is going to come from.

Meisha also likes photography and to play ultimate Frisbee.