Mulloon Institute
For environment, farming and society.

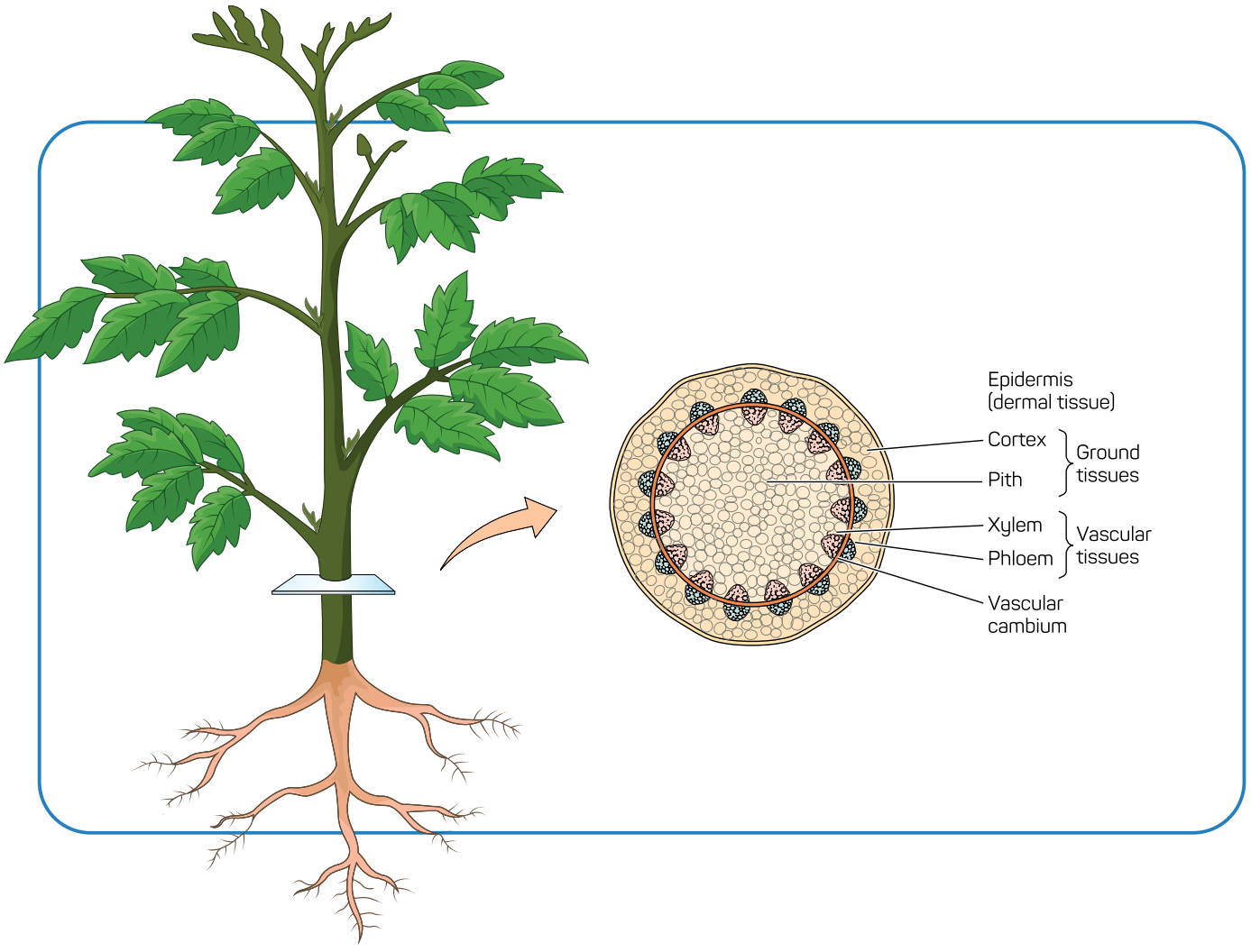
Plants are Pumps!

A painting activity to explore how plants cool our climate.

The sun's energy is so powerful that if the Earth's surface wasn't covered with plants, no other life could survive. Plants have evolved to manage this energy, to make the oxygen we breathe, and cycle water between atmosphere and biosphere. The removal of plants for agriculture, cities and industry has destabilised our planet's climate. By bringing plants back and enabling them to thrive, we can play a role repairing our water cycle.

This exercise can assist students to understand:

- The small water cycle
- The soil-plant-atmosphere connection
- Properties of water
- Evapotranspiration
- Condensation
- Plant anatomy
- How plants manage the sun's powerful energy to buffer climate extremes



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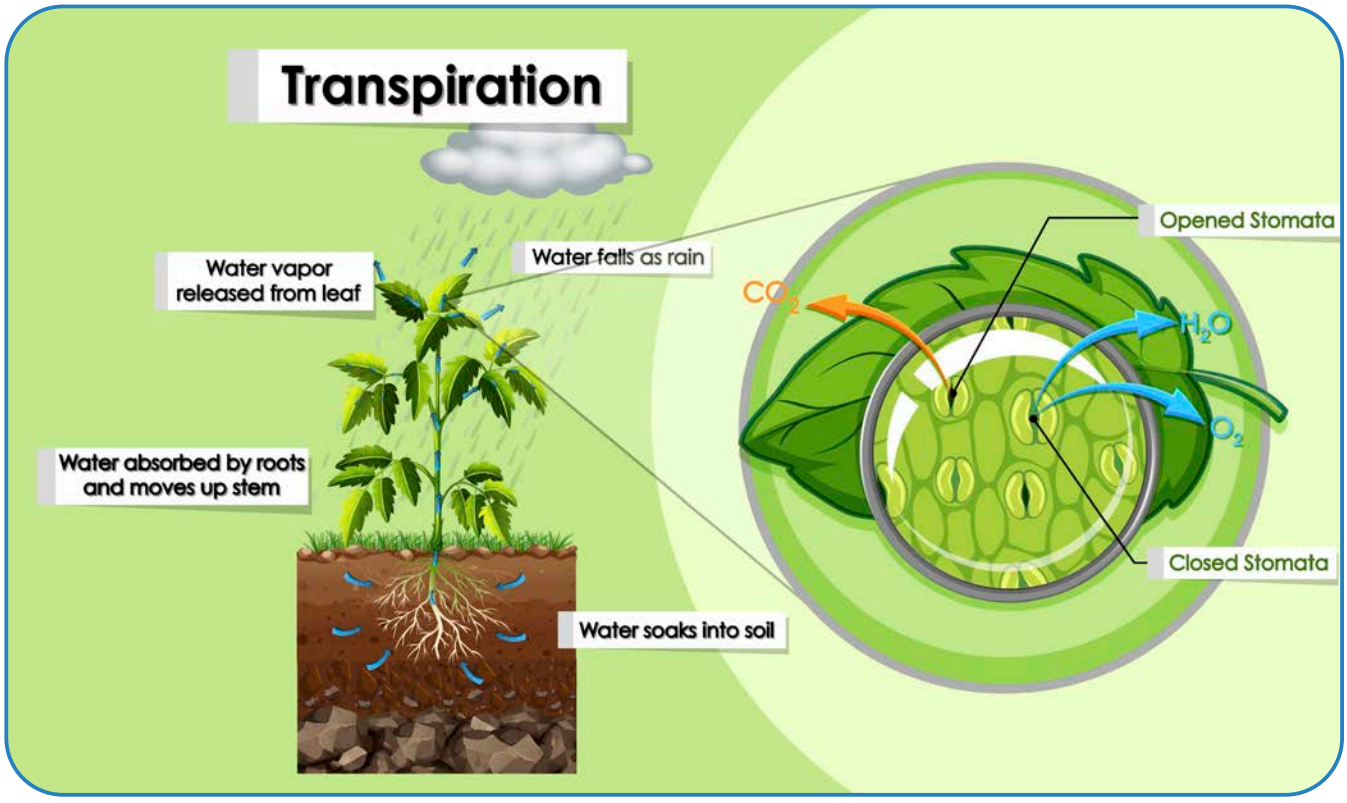
Scientific background

How plants cycle water

Plants are like little factories with many processes going on within. The ones we focus on in this booklet have a very important function: maintaining the small water cycle. The small water cycle circulates water between land and atmosphere at the local level every day. This intricate plant-water relationship cools and hydrates our environment and buffers the sun's powerful energy.

A plant's stem is like a bundle of straws with different tubes transporting water, oxygen, minerals and nutrients between the soil and the atmosphere.

The tube that transports water is the xylem. Xylems are located within vascular bundles inside the plant. Water moves upwards from the soil through the roots into the xylems and towards the leaves. It defies gravity in this way due to atmospheric conditions outside the plant and capillary action, which enables water molecules to "climb uphill" due to the forces of adhesion, cohesion and surface tension. The water is finally released as vapour from tiny pores on the leaves called stomata. This process is called evapotranspiration. Critically, it involves water changing from liquid to gas.



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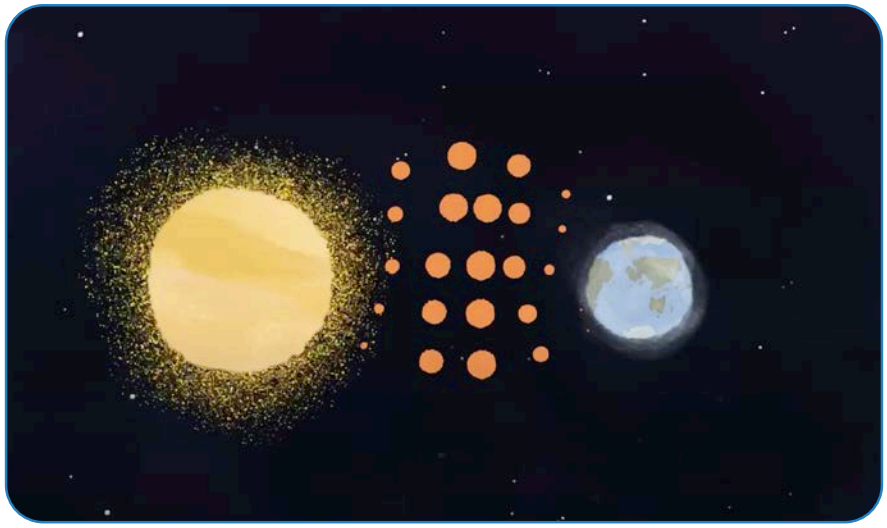
As we know from boiling a kettle, for water to vaporize it must heat up. Plants use heat energy from the sun to make this happen. Let's remember there is plenty of this energy to go around. In fact, 173,000 terawatts of solar energy hit the Earth continuously. The power of this energy is why our living planet is so unique in the universe. Life on earth depends on the small water cycle to manage and transform this energy.



Let's look more closely at how plants manage this energy. For 1 gram of water to convert from liquid to vapour, 540 calories of heat energy are required. That's equivalent to the energy in two scoops of icecream! This means that for a plant to transpire just 1 teaspoon of water - 2.5 grams - it uses the same number of calories as 5 scoops of icecream! (1350 calories)!

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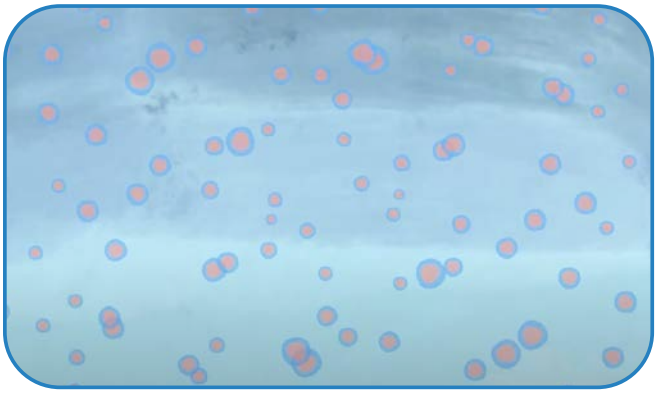
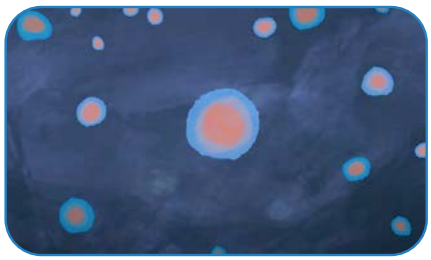
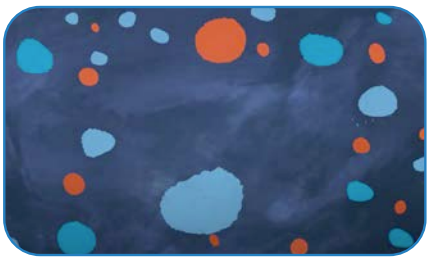
If this captured energy was visible to us, we would see the world through a sea of vapour molecules in the air around us, each holding a tiny bit of heat energy.



This humid air is known as 'latent heat'. To understand this, compare the feeling of standing in a damp forest to the feeling of standing on hot tarmac on a sunny day. The humidity surrounding us in the forest is latent heat, whereas the heat we feel radiating from the tarmac is 'sensible heat'. When we tune into these different sensations, we can sense how our planet's moderate climate depends on plants pumping out moisture to capture the sun's heat and transform it into humidity. In other words, our landscapes have evolved to 'sweat' to keep cool.

As the word 'cycle' suggests, water vapour never stands still. When the sun sets or the weather changes, air temperatures cool down. As the tiny balls of vapour release the heat energy they had captured before, they turn back to liquid. The liquid water condenses on plant surfaces and around particles in the air, forming rain clouds, fog, mist and dew. Some of this liquid will fall back to earth and soak into the soil. And the cycle will start again.





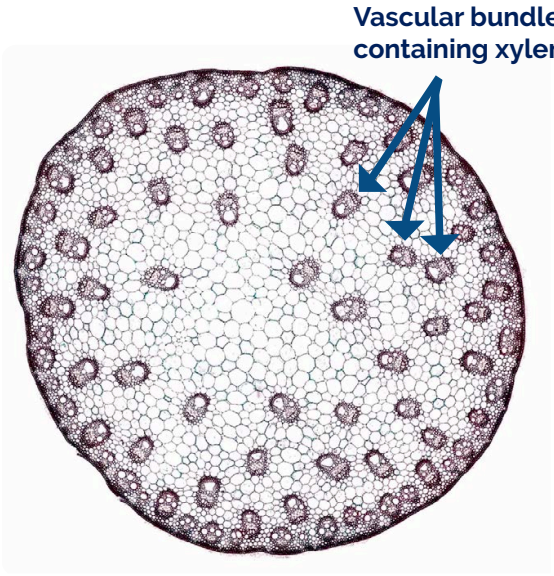
This painting exercise engages students in understanding how plants function to manage the small water cycle. It focuses on the microscopic cross-section of the plant stem, to highlight their tubular structure.

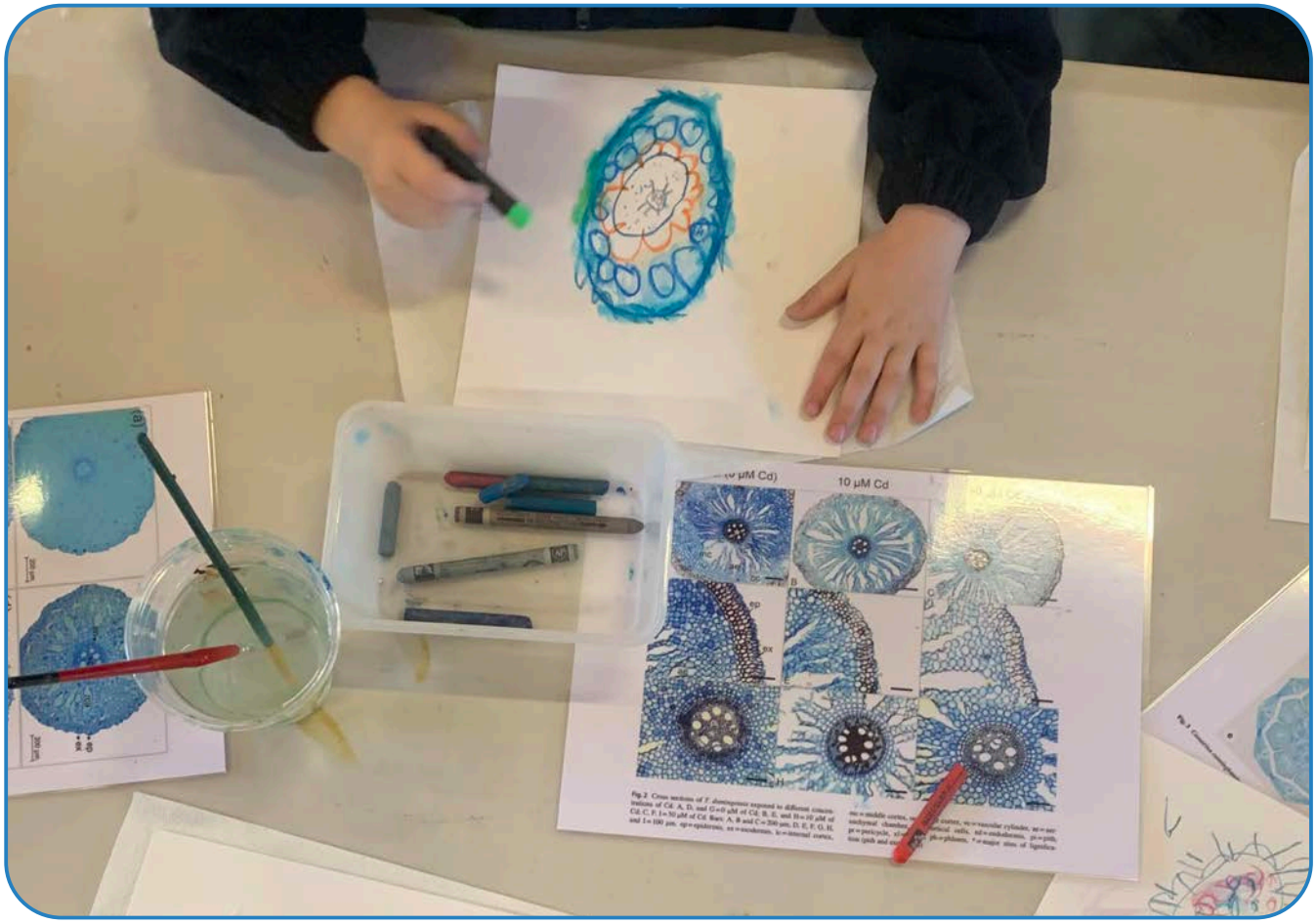
You will need:

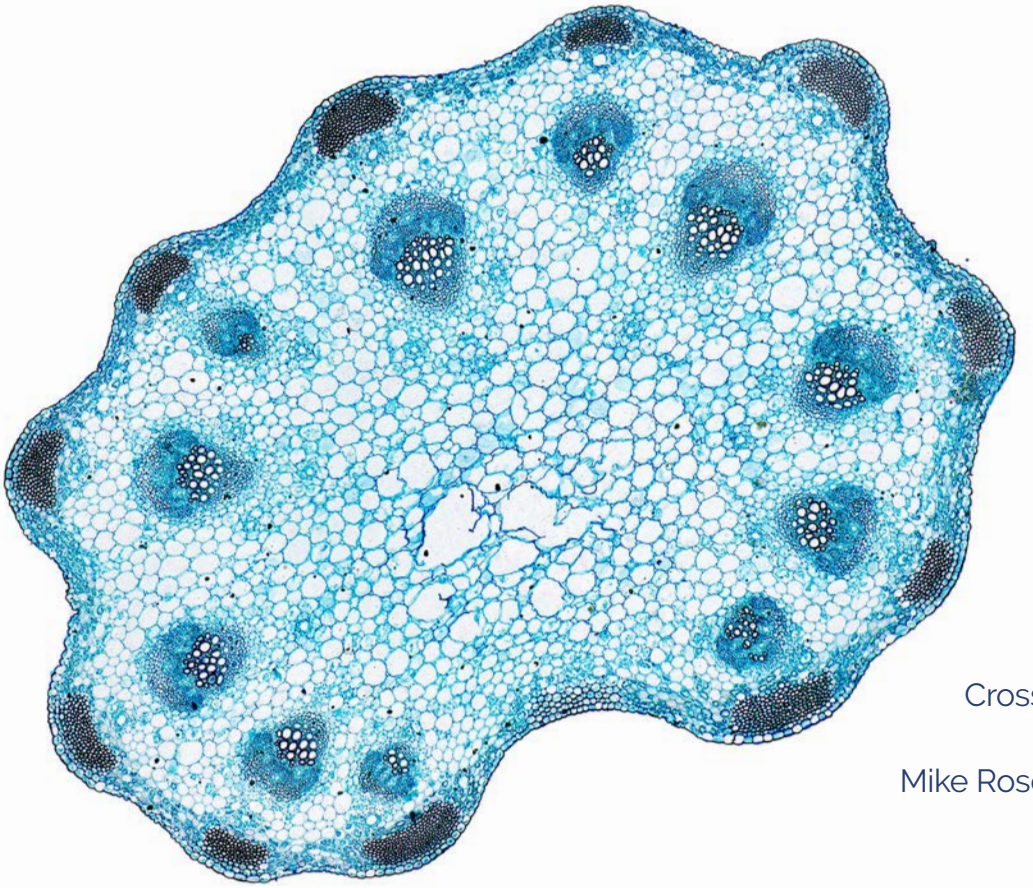
- Aquarelle pencils (watercolour pencils, can be bought from an art shop)
- Small paint brushes
- Small containers for water
- A bundle of straws
- Aprons or smocks
- Watercolour paper (or thick art paper)
- Microscopy images of plant stem cross-sections (can be found with internet search, or use the two in this booklet)

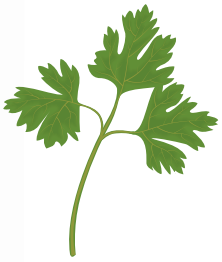
Activity

1. Show the students the bundle of straws and ask them to imagine seeing the stem of a plant up close. Show them the pictures of the celery and corn stem cross-sections. Using the diagram on page 2, see if they can identify the vascular bundles which have the xylem in them.
2. Ask them to select an image to work from, and to create a picture of their cross-section. It is best to draw with pencils first then carefully add some water with the brush to add shading to their outlines.
3. Leave the artworks to dry.

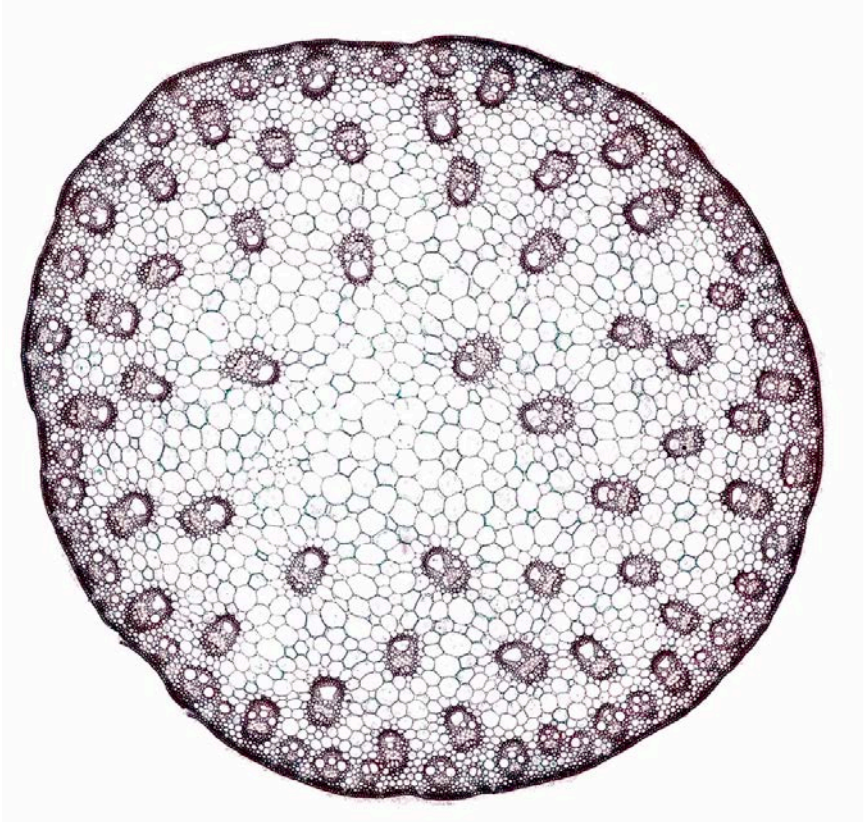








Cross-section of a celery stick
under a microscope
Mike Rosecope/Shutterstock.com



Corn stem cross-section
under a microscope.
Mike Rosecope/Shutterstock.com

This booklet is part of a series of educational resources produced by Mulloon Institute. The Institute is a not-for-profit, research, education and advocacy organisation dedicated to sustainable agriculture and environmental regeneration.

This resource has been created with the support of the Australian Government, through the Citizen Science project, 'Modelling Landscape Rehydration for Catchments, Communities and Curriculum'.

The illustrations on page 4 and 5 are stills from the animation *Solar energy: how plants, cycling water, manage the energy of the sun.*
It can be viewed at: themullooninstitute.org/education-community/#animations. This is one of five educational 'Water in Healthy Landscapes' animations produced by Mulloon Institute and animators Timothy Lee and David Lobb, all of which are suitable for younger viewers.

The photo above shows transpiration illustrations that featured in the 2022 exhibition *Waterland: the art, science and magic of water in our landscapes* presented by Mulloon Institute and Kandos School of Cultural Adaptation. This exhibition took place at WayOut Art Space in Kandos, NSW in October 2022, and featured artwork created by students from Ilford, Glen Alice, Capertee and Kandos Public Schools. The sand painting Bilagalang Murraway (River's path) featured in this image was created by Wiradjuri custodians Peter Swain and Emma Syme.

Mulloon Institute would like to thank the students, artists Kim Williams and Leanne Thompson, and regenerative science teacher Kym McMaster (The Scots College) for helping to develop this learning activity and publication.

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