Fascinating Plants
*Images and Stories from the ARC Centre for Excellence in Plant Energy Biology & Collaborators*

Plants are the lungs and bread-bowl of the Earth. They make the food we eat, create the oxygen we breathe and remove our waste carbon dioxide from the air. The world’s plants also produce six times more energy than humans consume each year.

Understanding and getting the best out of plants is ever more important in a world faced with climate change and dwindling resources.

The ARC Centre of Excellence in Plant Energy Biology brings together over 90 researchers from Australian National University, The University of Western Australia and The University of Adelaide.

Our scientists delve deep inside plants to study the tiny cells from which they are built. This photo display will take you on a journey through a plant’s world - from bushfires spanning hundreds of metres across, right down to cells and even molecules one millionth of a metre in length.

On May the 18th this year people from around the world will be celebrating International Fascination of Plants Day, so we hope this brochure helps you to become as fascinated with plants as we are! [http://www.plantday12.eu/](http://www.plantday12.eu/)

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**Smoke signals for plants**

Australian plants are among the world’s best at regenerating after bushfires. A team of scientists from Plant Energy Biology, UWA and Kings Park in WA discovered a molecule that helps plants to better adapt after a fire. Named after the Noongar word for smoke - *karrik* - the karrikin molecule helps stimulate seed germination in dormant seeds after a fire. *Image: Bushfire aftermath at Eneabba by Ben Miller, Botanic Gardens and Parks Authority, Kings Park.*

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**Energy from sunlight**

Plant veins transport water and nutrients to the leaves, where energy from the sun is used to convert carbon dioxide and water into plant sugars and oxygen. The veins then ship the sugars out of the leaf to where they are needed. Scale: 40mm across. *Image: Dew droplet on Coprosma repens (Mirror Bush) leaf by Sarah Rich, Plant Biology, UWA.*
Secrets of an underground orchid
This cute, quirky, critically endangered orchid spends its entire life underground. Despite the fact *Rhizanthella gardneri* cannot photosynthesise and has no green parts at all, it still retains chloroplasts - the site of photosynthesis in plants, but these chloroplasts have lost 70% of their genes. As the plant cannot photosynthesise, it steals its energy and nutrients from fungi in the soil. Scale: 20mm across. *Image: Catherine Colas des Francs-Small, ARC Centre of Excellence in Plant Energy Biology.*

The dark side of photosynthesis
Annual worldwide energy flux created during the light and dark reactions that make up photosynthesis is one thousand times the energy stored in all of Australia’s natural gas reserves. During the day sunlight is captured and turned into energy. At night, tiny pores on the leaves called stomata open, letting oxygen and water vapour out and carbon dioxide in, which will be fixed into plant sugars again during the day. *Image: Rachel Shingaki-Wells, ARC Centre of Excellence in Plant Energy Biology.*

Colours and carotenoids
The beautiful colours inside this *Darwinia leiostyla* flower come from pigment molecules called carotenoids. These powerful molecules play an important role in plant development, growth, energy production and cellular protection. Scale: 10mm across. *Image: Catherine Colas des Francs-Small, ARC Centre of Excellence in Plant Energy Biology.*

The lab rat of plant science
*Arabidopsis thaliana* (thale cress) is the lab rat of plant science. It’s studied by thousands of scientists around the world because it’s easy to grow, highly productive and completes its life cycle in only 6-8 weeks. Scale: 70mm across. *Image: Olivier Keech, ARC Centre of Excellence in Plant Energy Biology.*

Plants get hairy too
A close up of a poppy flower bud reveals it is covered in tiny hair-like protective structures called trichomes, which provide protection from frost and water loss and can keep predators and pests away. Scale: 30mm across. *Image: Rachel Shingaki-Wells, ARC Centre of Excellence in Plant Energy Biology.*
Busy bees
A colony of bees has to fly 177,500 km and pollinate 4 million flowers to make one kilogram of honey. As the bees collect nectar and pollen from millions of flowers they connect the plant's male genes with female parts of other flowers. In this way, one third of our food crops are fertilised. Image: Ben Gully, School of Chemistry and Biochemistry, University of Western Australia.

The secrets of seedlings
Plant seedlings have all the same genetic material as fully-grown plants, so genetic experiments are often performed on young plants to save time. Image: Rachel Shingaki-Wells, ARC Centre of Excellence in Plant Energy Biology.

Molecules and micropipettes
A micropipette is an instrument used in molecular science that can measure one millionth of a litre of liquid (one microlitre). This is essential when you study the interactions of molecules inside plant cells. Image: Olivier Keech, ARC Centre of Excellence in Plant Energy Biology.

Tracking genes in flowers
By using a dye that changes from clear to blue when a particular gene is turned on, this photo reveals which parts of the Arabidopsis thaliana flower are breaking down fat (they’re stained blue). Fatty molecules have many roles in plants, including providing energy to growing flowers. Some of these fatty molecules are hormones, which send chemical signals to cells to control development. Scale: 2mm across. Image and research: Andrew Wiszniewski, ARC Centre of Excellence in Plant Energy Biology.
Energy for embryos
This Arabidopsis thaliana (thale cress) plant embryo reveals two leaves and a primary root. Peroxisomes, which break down oils to give the dormant seed the energy boost it needs to become a seedling, have been stained with a green fluorescent dye. Scale: 0.8mm. Image and research: Simon Law, ARC Centre of Excellence in Plant Energy Biology.

Antioxidants for embryos
Flavonoids are pigment molecules that have many roles in plants, including protection from UV rays. The red fluorescence of this Arabidopsis thaliana embryo reveals the flavonoids accumulating in the developing seed leaves. Scale: 0.8mm across. Image and research: Andrew Wiszniewski, ARC Centre of Excellence in Plant Energy Biology.

Roots for vitality
Small root hair cells are sprouting from the primary root of this germinating Arabidopsis thaliana seedling. These hairs provide the root with a greatly increased surface area, aiding in the uptake of water and vital nutrients. Scale: 0.4mm across. Image and research: Simon Law, ARC Centre of Excellence in Plant Energy Biology.

Learning more about genes
It may look a lot like a sea creature, but it's a close up of the male and female parts of a flower (right and left, respectively). Look closely and you can see pollen grains in the male anther. In this image, the blue areas show the location of genes being turned on in response to drought stress. Scale: 0.8mm. Image and research: Vindya Uggalla, ARC Centre of Excellence in Plant Energy Biology.
Lasers for plant science
Rather than letting the useful materials of a dying leaf go to waste, this plant is pulling them out through a process called senescence. In this cross section of a leaf, the red blobs show chloroplasts, where sunlight is captured to make energy; the green dots are mitochondria - another energy-producing organelle - and the blue areas are cell walls. Scale: 0.291mm across. Image and research: Olivier Keech, ARC Centre of Excellence in Plant Energy Biology.

Cargo rails in plant cells
Sugar and proteins are distributed within a plant cell by the actin cytoskeleton - a network of tiny filaments highlighted in this image by fluorescent protein. Energy organelles like mitochondria and chloroplasts also use the cytoskeleton to move around. The oval-shaped pores are stomata, which allow carbon dioxide, oxygen and water in and out of the plant. Scale: 0.085mm across. Image and research: Olivier Keech, ARC Centre of Excellence in Plant Energy Biology.

Discovering where proteins go
When scientists discover a new protein how do they work out what it does? By fusing a green fluorescent protein to the new protein, they can track it within the cell - in this case to the endoplasmic reticulum network, a factory that produces and packages proteins and carbohydrates. Scale: 0.072mm. Image and research: Botao Zhang, ARC Centre of Excellence in Plant Energy Biology.

Female parts of a flower
A close up of the inside of a tulip flower reveals the three-pronged stigma. When the flower is pollinated, pollen gets caught on the sticky stigma, then grows down a stalk called the style until it reaches the female ovary. Scale: 20mm across. Image: Rachel Shingaki-Wells, ARC Centre of Excellence in Plant Energy Biology.
The beautiful curse
This beautiful flower is part of one of Australia’s worst pasture weeds - Patterson’s Curse. Originally from the Mediterranean, each plant produces 10,000 seeds which lie dormant in soil until rainfall triggers their germination. A large "taproot" makes the plant resistant to drought. Image: Rachel Shingaki-Wells, ARC Centre of Excellence in Plant Energy Biology.

Plant sex is pollination
For a plant to pass on its genes, it must reproduce. Plants can do this sexually, by pollination, or asexually, such as budding off a new plant with the same genes. Sexual reproduction requires that pollen from a flower's stamens (pictured right), which contains plant sperm, must reach the female sex cell, or ovule. For most plants this happens via wind or an animal pollinator. Image: Michael Whitehead, Research School of Biology, Australian National University.

The birds, not the bees
Australia’s iconic kangaroo paw is perfectly designed for pollination by birds. When a bird inserts its beak to feed on the nectar inside the flower, pollen is brushed on its head. Different species of kangaroo paw are shaped to deposit pollen on different parts of the bird head, which avoids cross-fertilisation between different species. Image: Ben Gully, School of Chemistry and Biochemistry, UWA.

Sexual Deception
Orchids have weird and wonderful ways to achieve pollination, like "sexual deception”. The hammer orchid (pictured right) sexually attracts male wasps by sending out chemical signals. These signals trick the male into thinking the flower is a female wasp. When the male attempts to mate with and fly off with the flower, it is tipped upside down where pollen transfer occurs. The wasp then carries the pollen to another orchid, therefore achieving pollination. Image and research: Rod Peakall, Research School of Biology, ANU & Gavin Flematti, UWA.
Understory beauty
Where could be a better place to undertake plant research than the biodiversity hotspot of southwest Western Australia? This native *Beaufortia sparsa* is a radiant resident of the marri and karri forest understory in the Denmark region of the south coast of WA. Its flowers are actually inflorescences made up of hundreds of individual flowers, each with curiously forked filaments that present the plant’s pollen to the birds and small mammals that pollinate it. Image: Rowena Long, UWA.

Epidermal Kaleidoscope
This image shows the underside of a paper bark tree leaf, viewed under ultraviolet light on an epifluorescence microscope. The blue cells you see are specialised guard cells. These surround the stomata, which are pores in the leaf which take up carbon dioxide for photosynthesis. The carbon dioxide is fixed into carbohydrates within the chloroplasts, which are visible in red. The dark patches are leaf oil glands, which protect the leaf and produce tea tree oil. Image and research, Elizabeth McLean, UWA.

A web of roots
The image captures the root systems of five hydroponically grown *Arabidopsis thaliana* plants. The root system anchors the plant in place and is responsible for uptake of water and almost all nutrients and minerals from the soil. Root interactions with environment and root to shoot (leaf) signalling are critical for a plant’s ability to respond to a changing environment. Image and research: John Bussell, ARC Centre for Excellence in Plant Energy Biology.

Australia’s Highest Tree
The snow gum (*Eucalyptus pauciflora*) is an iconic Australian tree species with a story to tell. This tree dominates the high altitude woodlands of south east Australia. In 1972, Professor Ralph Slatyer of ANU investigated whether snow gums were capable of growing even higher up the mountains then they usually did, and planted them at 2100 m above sea level! Forty years later, these trees can still be found thriving up high in the alpine zone. Image: Owen Atkin, Research School of Biology, ANU.

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