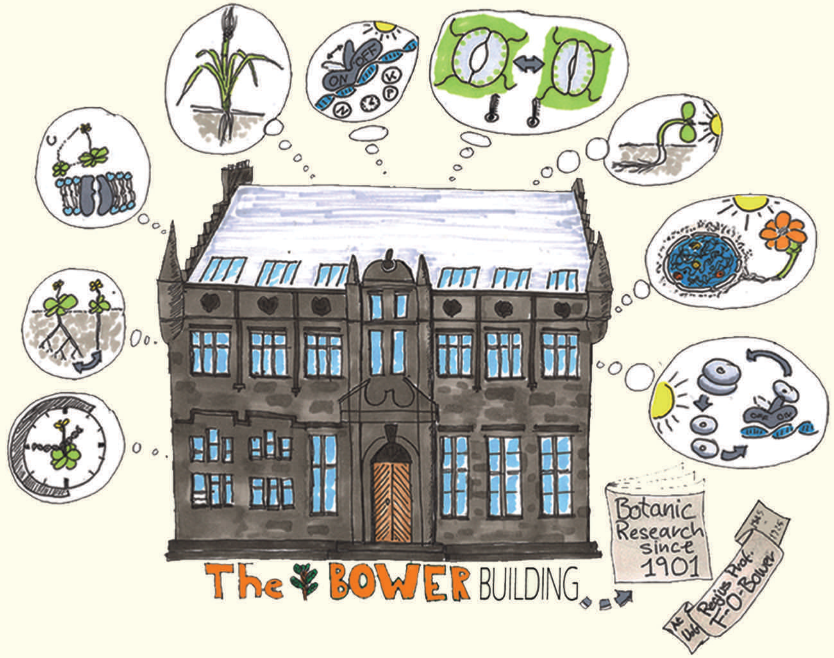
PLANT SCIENTISTS

Glimpses into the Minds



Do you think plants are very different from humans???
Do they see? Do they move? Do they breathe? Can they tell time?
Do they need sunscreen? How do they grow? Do they stress?

Look inside to find out!

Plant Science Group
University of Glasgow

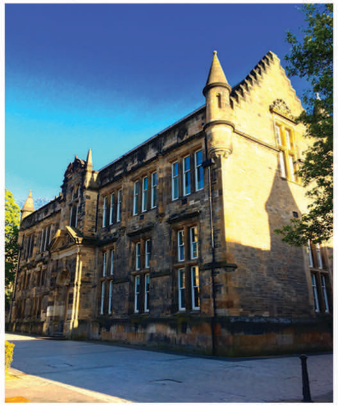
Institute of Molecular, Cell and Systems Biology

Welcome To Glimpses Into The Minds of Plant Scientists!

Who, Where and What?

The University of Glasgow has been the centre for excellence in plant science research and teaching for over two centuries. Glasgow boasts the first Regius Chair in Botany. The Professorship was instituted by King George III in 1818 and is granted by Royal Charter. The Regius Chair recognises the exceptionally high quality of research at Glasgow that continues to this day.

The Plant Science Group (PSG) at the University of Glasgow is based in the Bower Building which is situated on the Gilmorehill Campus in Glasgow's West End. It currently houses nine laboratories with over 50 plant scientists who engage in fundamental and applied research.



The Bower Building is, itself, a historical landmark that dates back to 1901. Named for Frederick Orpen Bower, who was the Regius Chair of Botany from 1885 to 1925, this beautiful building was extensively damaged by fire in 2001. The building was reopened in 2005 following reconstruction with modern interiors. It currently houses state-or-art facilities and equipment for fundamental research, including advanced molecular and biochemical suites, imaging facilities, plant growth chambers, plant illumination suites, and laboratories for research in plant physiology, photo-biology, cell biology and biochemistry.

University of Glasgow

WORLD CHANGERS WELCOME

Plant Science -At The Forefront of Biological Research

Plants are some of the most intriguing and diverse living organisms. They form the basis of life on planet Earth as they provide food, fuel and even the oxygen we breathe. Plants are vital to maintaining the environment of our planet.

Research in plant science is central to facing global challenges of the modern world inculding food security, renewable energy, environmental conservation and climate change.

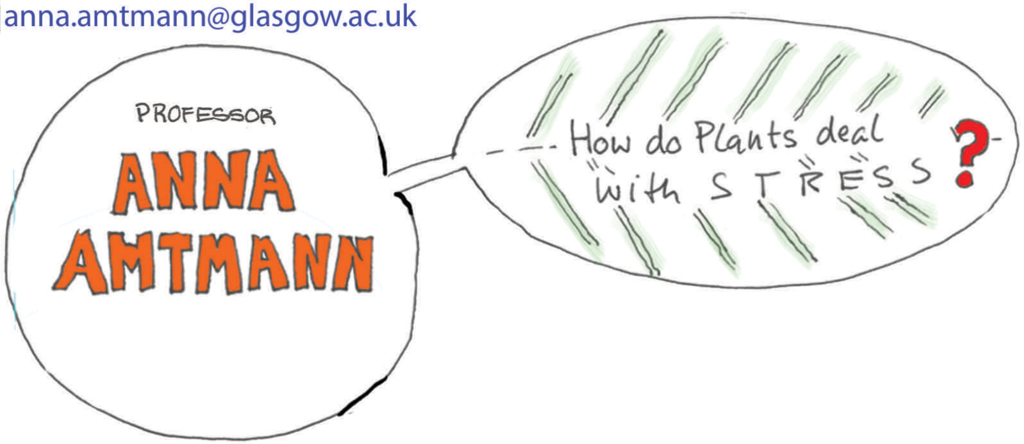
Plant scientists are addressing these challenges using multidisciplinary approaches to gain fundamental knowlege about plants and to utilise this knowledge in developing technologies that will yield plants with improved disease resistance, stress tolerance and developmental characteristics. Modern plant science leads the way in developing new strategies for fundamental research in biology.

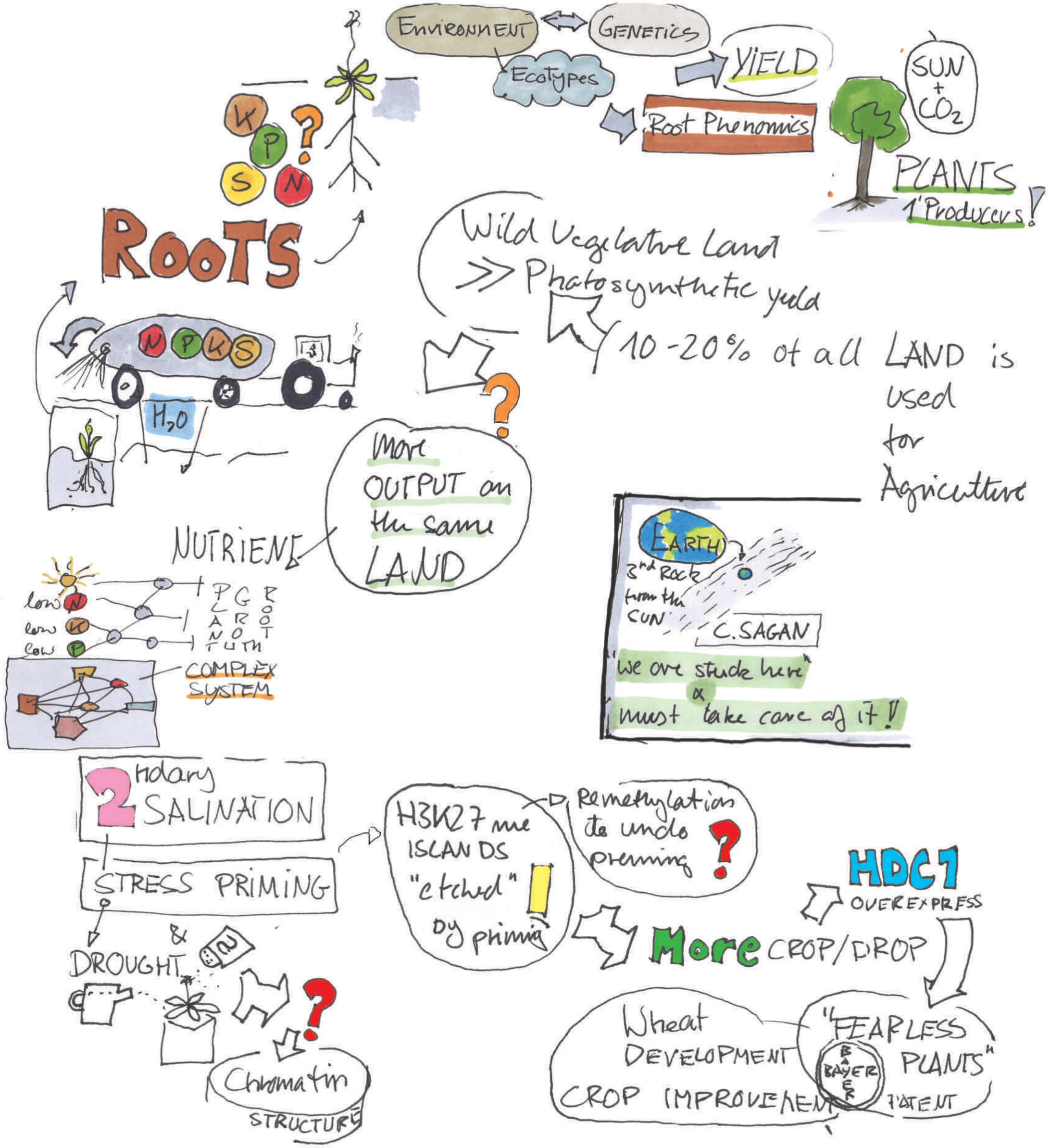
This book showcases the cutting edge research carried out by the Plant Science Group at the University of Glasgow.

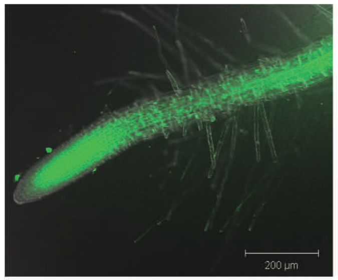
Detailed information on PSG research interests and opportunities can be found on at http://www.gla.ac.uk/researchinstitutes/biology/.
For more information on our outreach activities, educational resources and for directions to send us photos of your personalised coloured booklet visit https://www.ugplantsci.org/

The long-term goal of our research is to make crop production more sustainable by improving water and nutrient usage efficiency of plants. In my laboratory we apply a range of molecular techniques to investigate the regulatory processes that enable plants to optimally forage the soil for minerals and water. We also collaborate with several Scottish companies to develop photosynthetic bacteria into light-powered cell factories to produce valuable pigments and polymers with applications in healthcare.

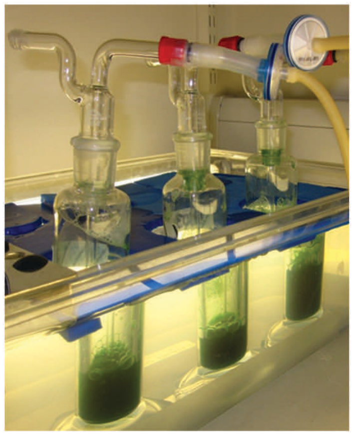
Professor for Molecular Plant Physiology
IMCSB, University of Glasgow
anna.amtmann@glasgow.ac.uk





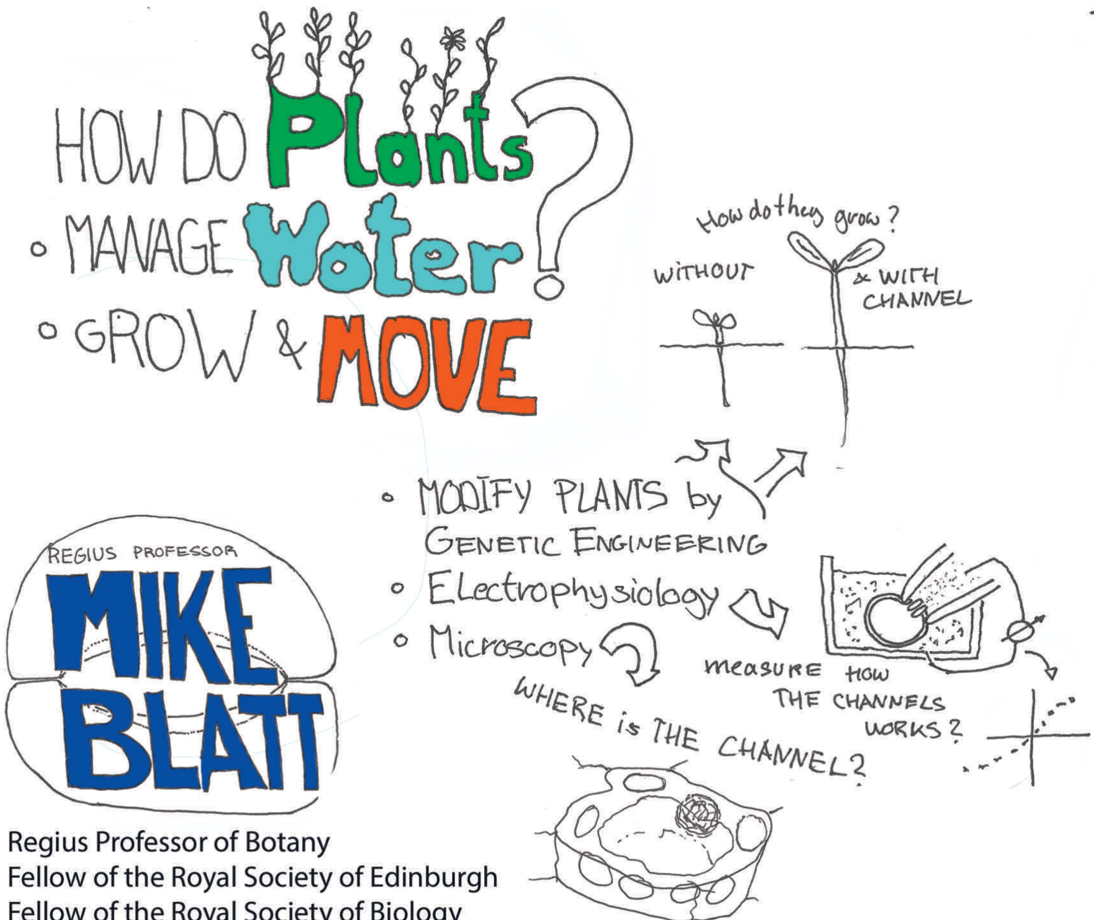


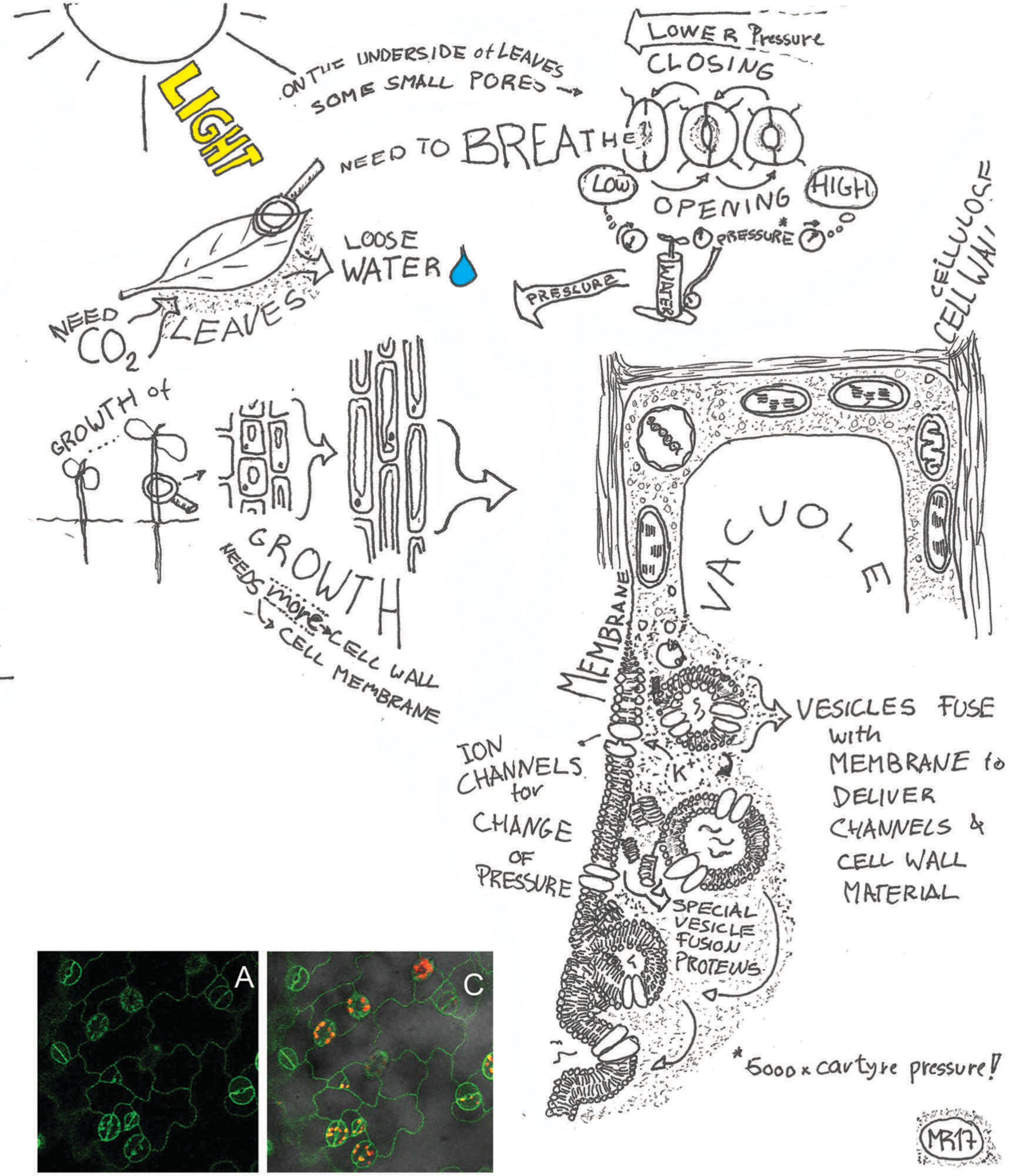
A fluorescent dye highlights accumulation of reactive oxygen species (ROS) in the root tip of an Arabidopsis thaliana plant grown with low supply of mineral nutrients. ROS act as a signal for plants to stimulate the growth of root hairs and enhance nutrient uptake.



Cyanobacteria are photosynthetic CO_2 -fixing bacteria. Synthetic biology approaches are used to develop them into 'green' cell factories for applications in Industrial Biotechnology.

EPSRC
BBSRC bioscience for the future
The Leverhulme Trust
The Gatsby Charitable Foundation
IBioIC



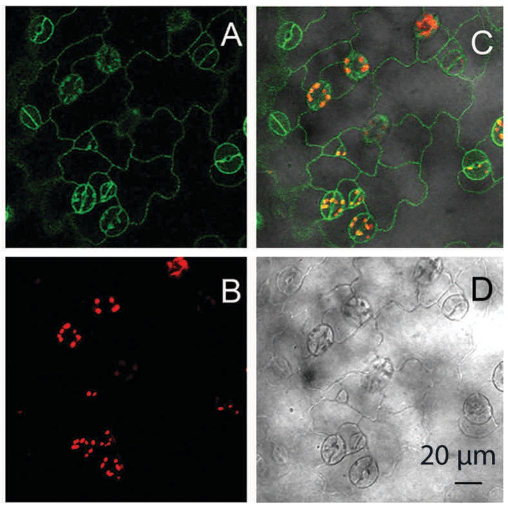


Regius Professor of Botany
Fellow of the Royal Society of Edinburgh
Fellow of the Royal Society of Biology
Fellow of the John Simon Guggenheim Memorial Foundation
Laboratory of Plant Physiology & Biophysics, University of Glasgow

Our laboratory studies membranes. Membranes are essential for life. They surround all cells, move materials in and out of cells, and change shape and size. We are interested in how cells regulate these properties of membranes and their vital importance for fundamental processes of growth and photosynthesis that give use basic food and biological materials to support human existance.

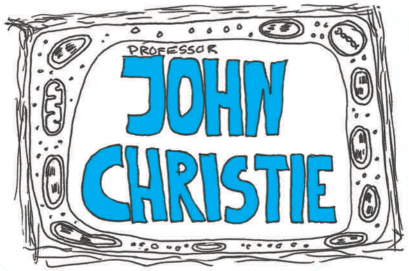
mike.blatt@glasgow.ac.uk

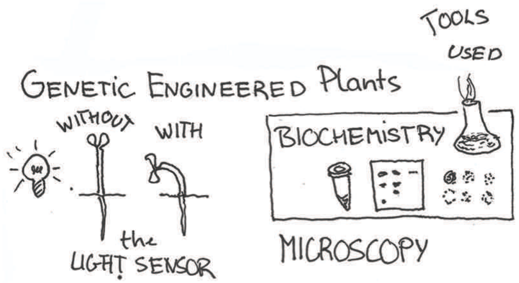
BBSRC bioscience for the future
John Simon Guggenheim Memorial Foundation
NSF
THE ROYAL SOCIETY
The Leverhulme Trust



Images of the leaf epidermal surface showing (A) K^+ channels in green, (B) chloroplast autofluorescence in red, and (C) the overlay of these images . (D) shows the corresponding brightfield image. Images acquired with a confocal microscope.

How do PLANTS SEE to capture as much LIGHT as possible?



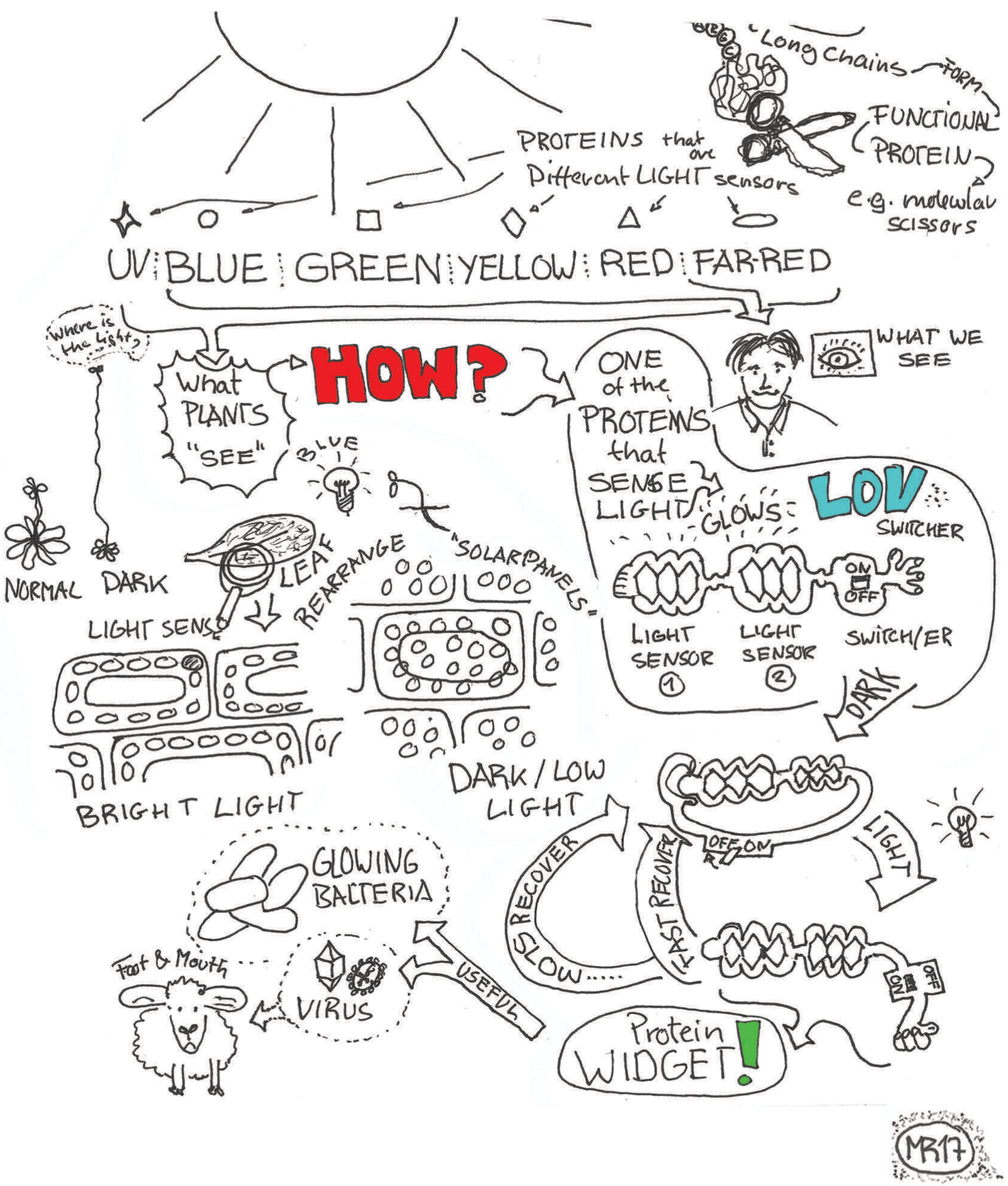


Our research centres on the use of diverse approaches, ranging from the biophysical to the physiological, to understand how adaptive blue light responses, such as phototropism operate to coordinate and shape plant growth and development. By doing so we aim identify new strategies to coordinate stepwise enhancements in photosynthetic performance to increase plant productivity and yield.

Professor of Photobiology
Fellow of the Royal Society of Edinburgh
IMCSB, University of Glasgow
john.christie@glasgow.ac.uk

Plant stems can see and move towards blue light, whereas their roots move away.

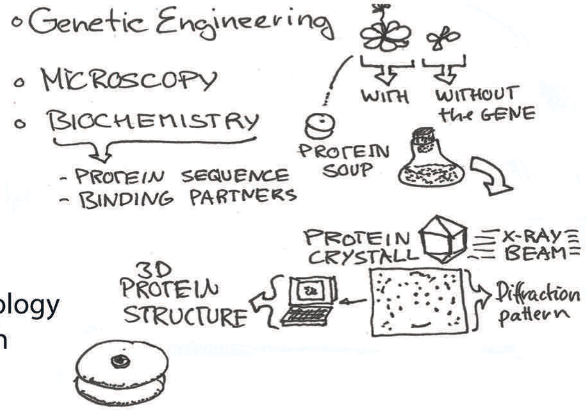
A green glowing molecule made from a plant photoreceptor can be used to track the spread of a virus within the leaf.



BBSRC
bioscience for the future
The Gatsby Charitable Foundation

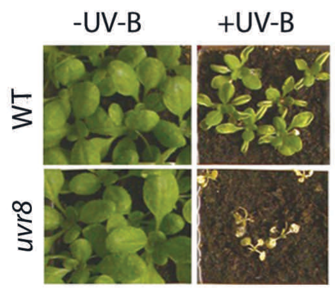
How do Plants Respond to Ultraviolet LIGHT?

PROFESSOR
GARETH JENKINS

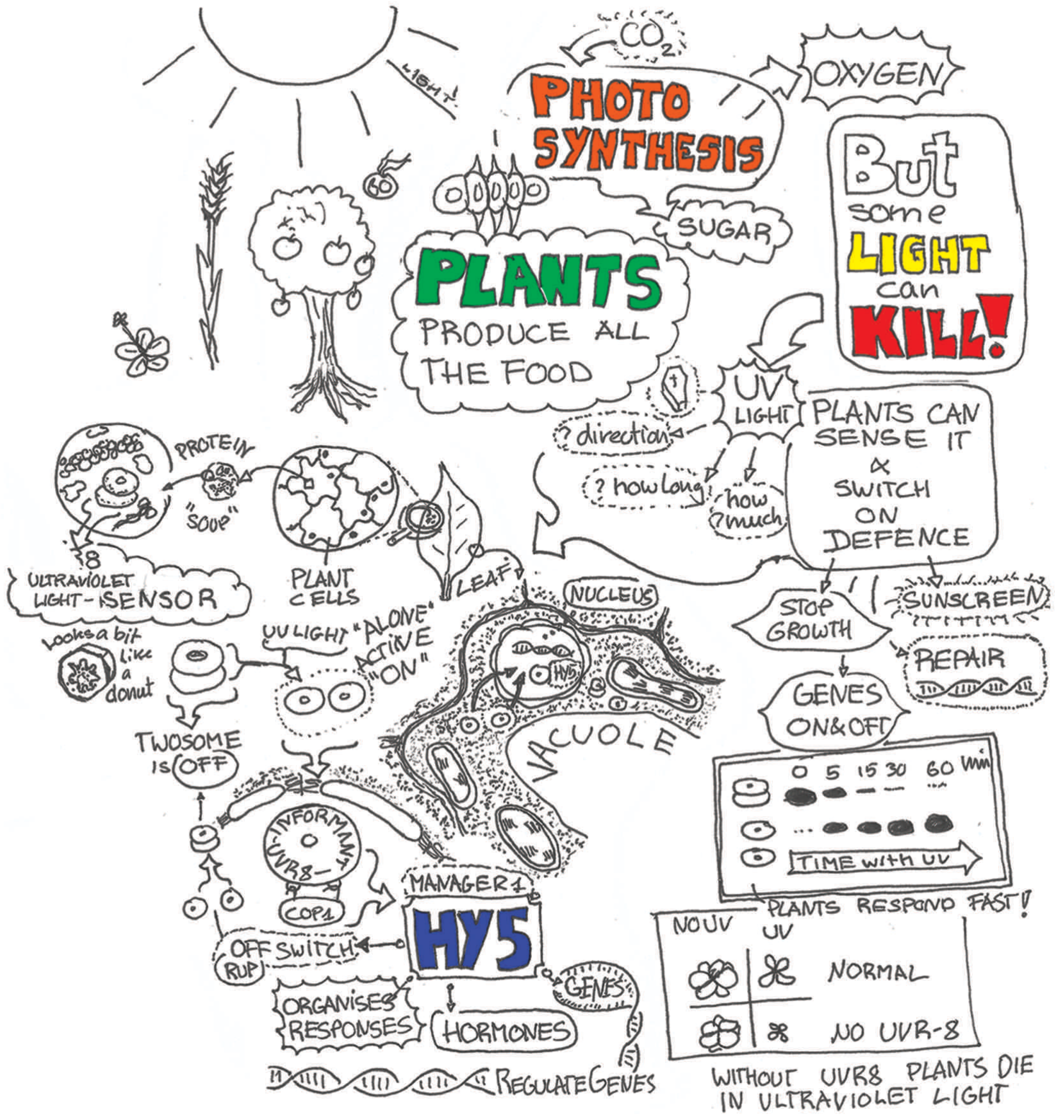


Professor of Plant Cell and Molecular Biology
Fellow of the Royal Society of Edinburgh
Fellow of the Royal Society of Biology
IMCSB, University of Glasgow
gareth.jenkins@glasgow.ac.uk

The broad aim of our research is to understand how light, particularly ultraviolet-B light regulates plant growth and development. We study plant responses to UV-B light and how they regulate plant morphology, biochemical composition and defence against pest attack. We are investigating the structure and mechanism of action of the UV-B Resistance Locus 8 protein (UVR8) which functions as a UV-B photoreceptor. Molecular dynamics of UVR8 protein underpin regulation of gene transcription following UV-B light perception. Our research employs a combination of experimental approaches: biochemistry, biophysics, cell biology, genetics, molecular biology and photobiology, and principally involves the model plant *Arabidopsis thaliana* and the crop *Brassica napus*.



Plants express the ultraviolet-B receptor protein UVR8 which allows them to sense and protect against ultraviolet light in the range 280-315 nm. Wild type Arabidopsis plants expressing UVR8 show slower growth when exposed to UV-B, whilst UVR8 mutant plants die.



Structure of the UV-B photoreceptor UVR8 showing the pyramid arrangement of UV-B-sensing tryptophans across the two-molecule dimeric interface. Photoreception causes disruption of salt bridges that hold the dimer together, leading to monomerisation and hence signalling.

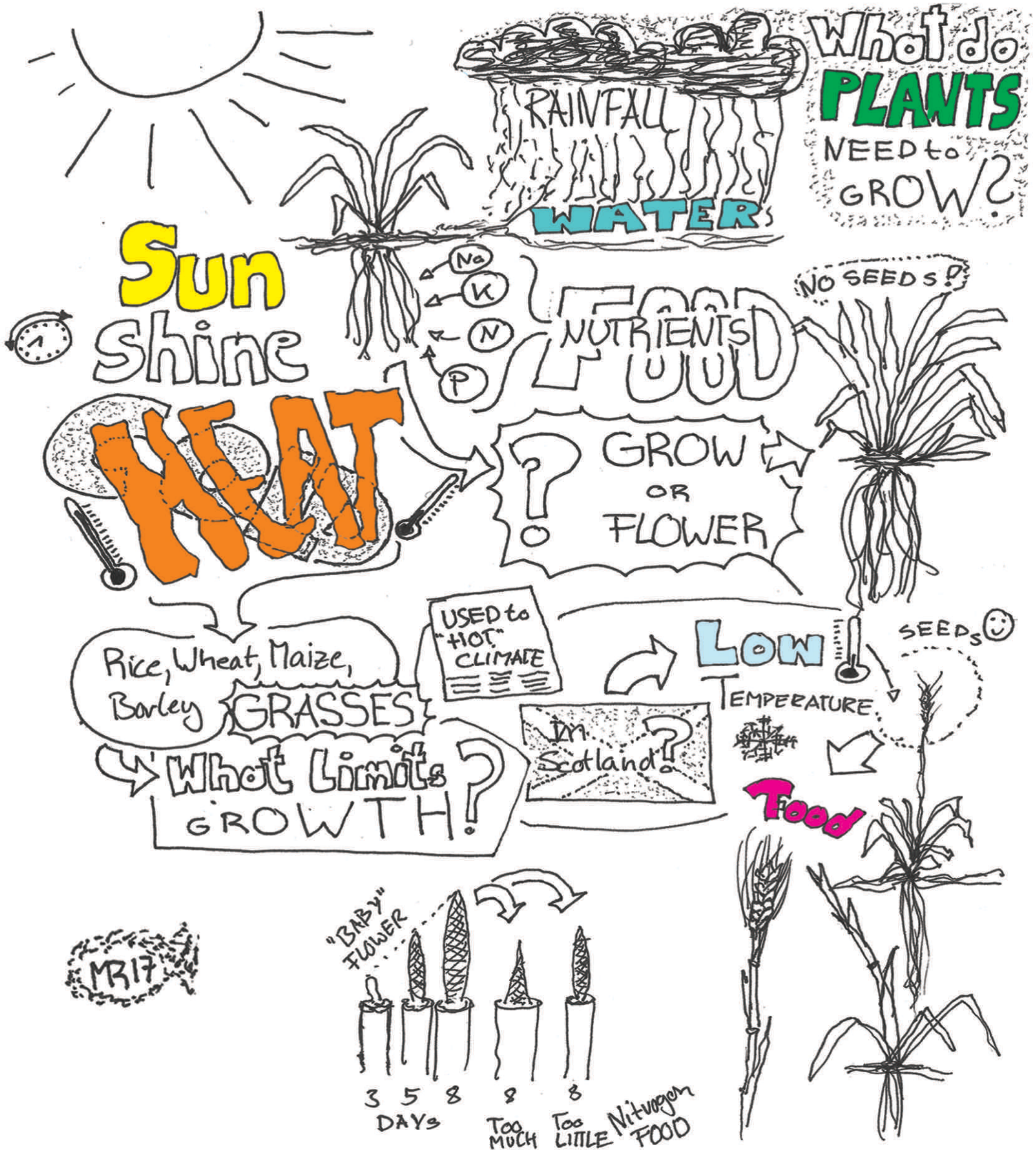
BBSRC
bioscience for the future

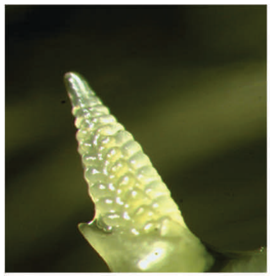
How to feed the WORLD?

PETER DOMINY

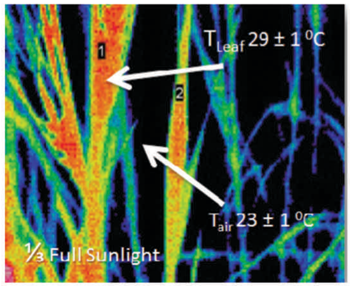
Senior Lecturer & Associate Academic
University of Glasgow
peter.dominy@glasgow.ac.uk

The most pressing problem for humanity in the 21st Century is 'how do we feed the world?'. Most of the land suitable for growing our major crops is already cultivated and although there are vast tracts of other land available, our (rather feeble) crops won't grow there. So why do some wild grasses survive the freezing winters of Siberia and others the hot arid conditions of central Australia, but not the grasses we know as wheat, rice, barley and maize? In these crops flowering and seed set, and the process of photosynthesis in green leaves, are particularly sensitive to extremes of temperature. We are trying to find out why this is so.



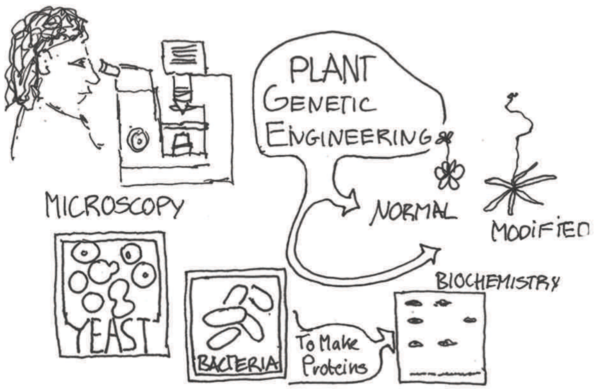


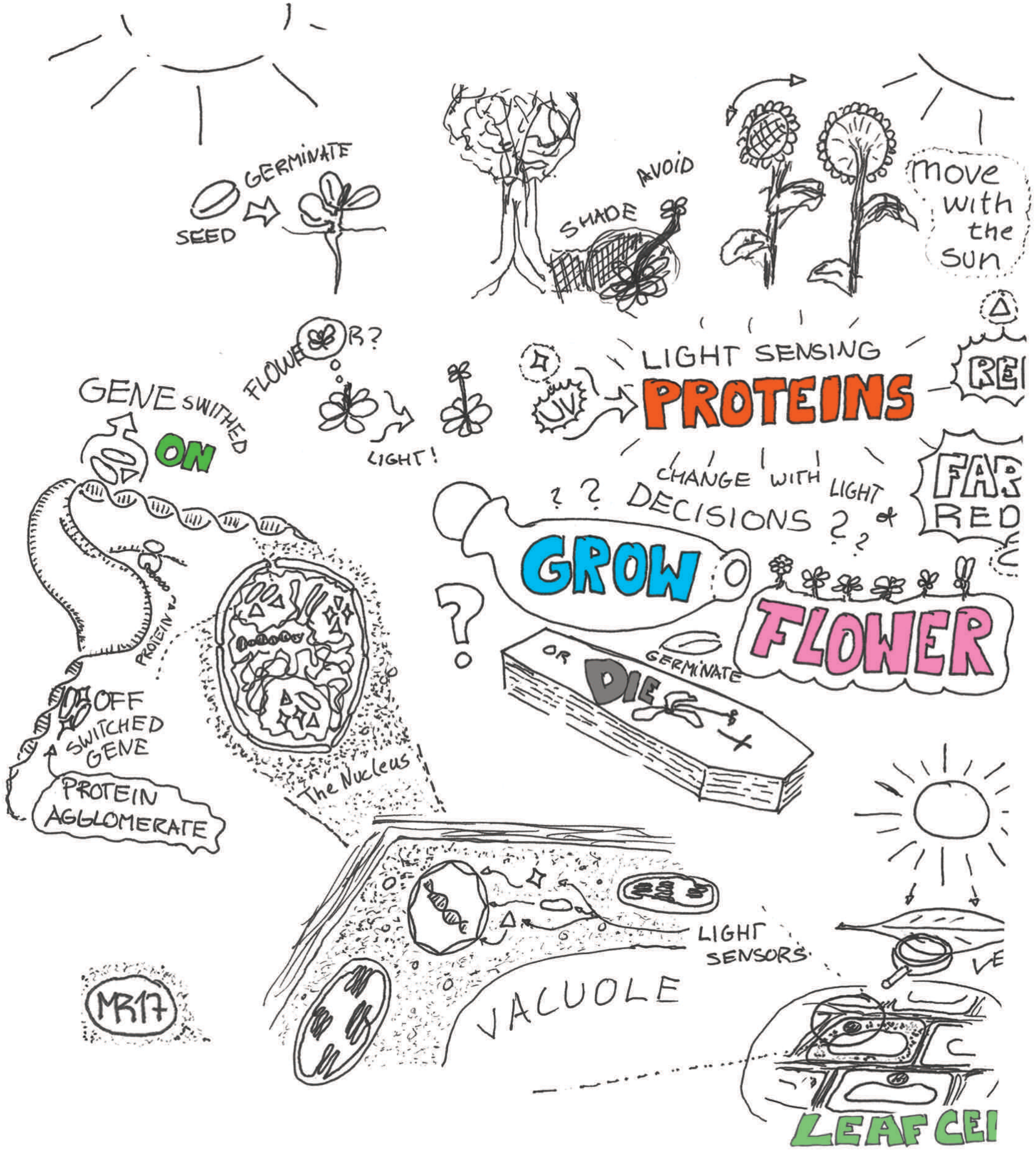
An image of a developing barley flower head (~1 mm long). The little bumps would normally become the grains on the ear; but not in this case! When the plant was exposed to a mild frost it destroyed the bud and prevented flowering.



A thermal image of barley plants growing on a warm day in Scotland; the air temperature was 21 degrees Celsius and about one-third of full sunlight. This is the kind of camera the Military and Police use to 'see in the dark'. It measures how hot an object is (black/blue 21-23 degrees; yellow 24-27 degrees; red/white 28–31 degrees). Even in cool and wet Scotland, leaves are often hotter than the air!

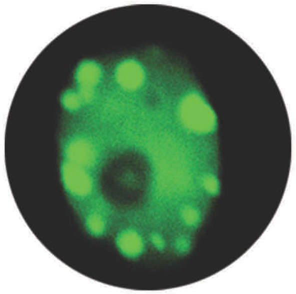
HOW Light shapes the LIFE of a PLANT



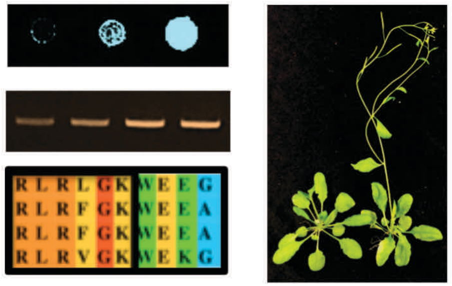


Our research focuses on how light shapes the life of a plant. In particular, we are interested in the "eyes" of the plant (photoreceptors) and the proteins they "socialise" with. The nucleus, also known as the "brain" of the cell is a popular hub where proteins exchange information and decisions are made. We are fascinated by these nuclear hubs and we want to find out what are the processes that switch genes on and off when proteins "illuminate" the nucleus.

J. Grieve Lecturer in Biochemistry
IMCSB, University of Glasgow
eirini.kaiserli@glasgow.ac.uk



Protein "neighbourhoods" or hubs within the "brain" of a plant cell as seen under a microscope.

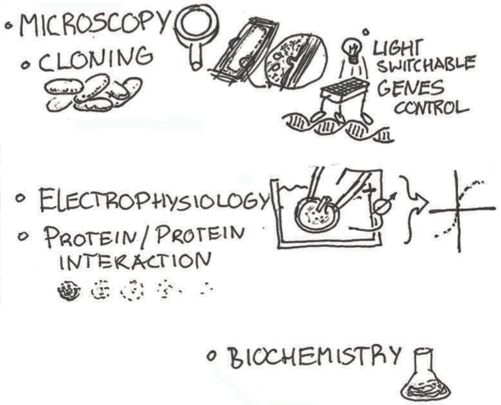


Diverse biological systems and methods used to understand how plants grow in response to light.

BBSRC bioscience for the future
wellcome trust

How do Plants GROW?

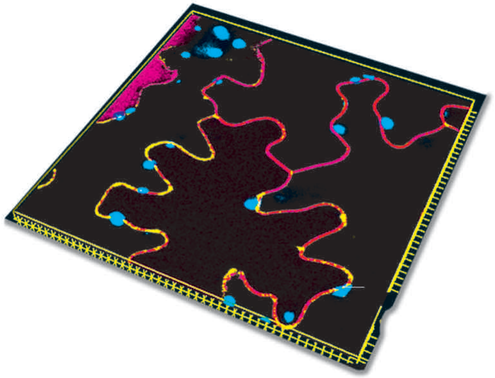
RUCHA KARNIK



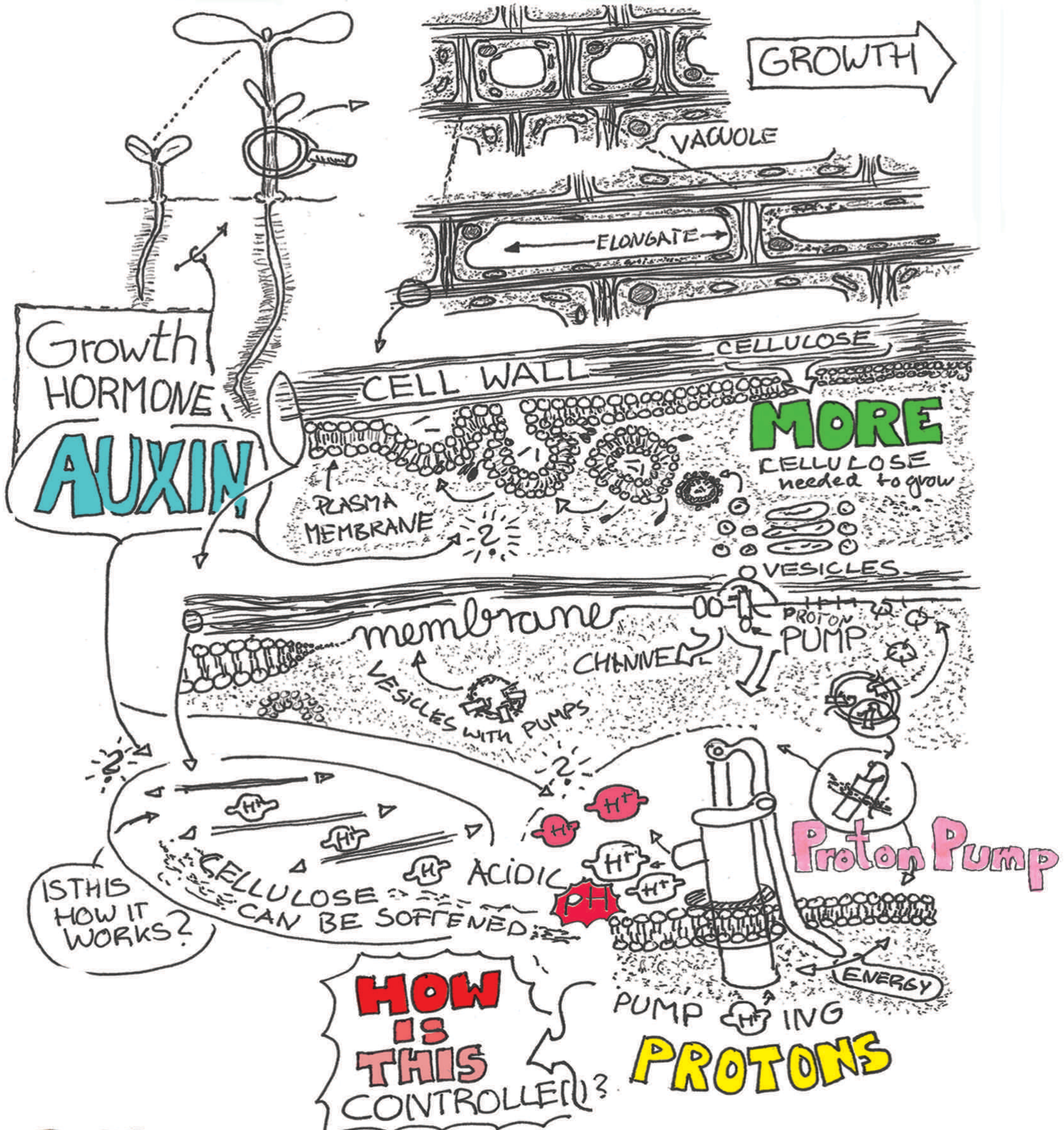
Royal Society University Research Fellow
IMCSB, University of Glasgow

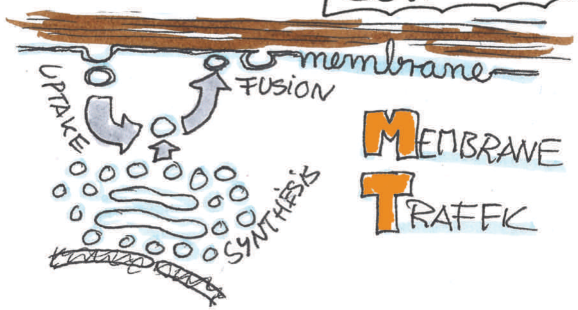
rucha.karnik@glasgow.ac.uk

Research to understand the mechanics of plant growth and development is vital to adressing the biggest challenges faced by the modern world - sustaining water and food availability. A rigid cell wall encapsulates the plant cells therefore cellular expansion requires the activity of H^+ pumps localised on the plasma membrane. H^+ pumping causes causes acidification and loosening of the cell wall. It also drives osmotic solute and water uptake to generate turgor pressure, allowing cells to expand. This 'acid growth' is regulated by the plant growth hormone auxin. We investigate novel auxin-regulated mechanisms for spatial and functional regulation of proteins involved in 'acid growth', especially the H^+-pumps and test how they affect plant growth and responses to the environment. We use *Arabidopsis thaliana* as models and also develop tools to aid research in this exciting field of plant cell biology.



3-D projection of eight 1.2 μm thick stack images of *Nicotiana tobaccum* leaf epidermis acquired using a confocal laser scanning microscope. Cells are expressing fluorophore tagged *Arabidopsis thaliania* H^+-pump (red) and plasmamembrane SNARE (green). The two proteins colocalise at some regions on the plasma membane (yellow). Chloroplasts are in blue. Scale bar =20 μm.



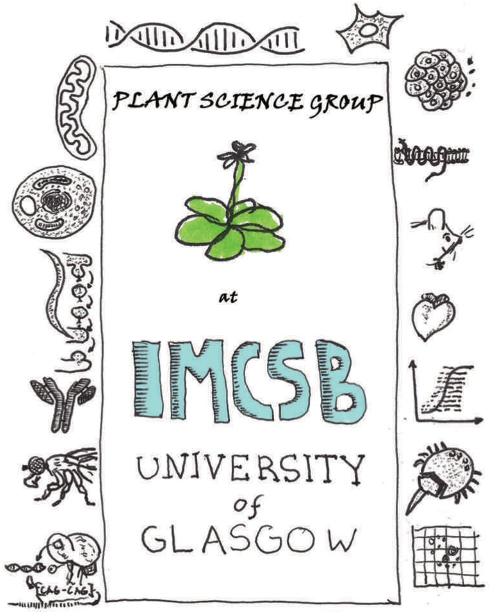


THE ROYAL SOCIETY

University of Glasgow

Plant Science Group at the University of Glasgow

The Plant Science Group (PSG) at the University of Glasgow is part of the Institute of Molecular Cell and Systems Biology (IMCSB). The Institute is home to over 200 scientists who work in specific research themes including Molecular Genetics, Protein Structure & Regulation, Molecular Pharmacology, Cell Engineering, Synthetic Biology, Systems Biology and of course, Plant Science! We all contribute to a thriving community that is committed to excellence in research and teaching.



The Institute is proud of our research excellence as well as our enthusiasm for adopting the Athena Swan Principles which promote gender equality and commitment to advancing the careers of women in science, technology, engineering, mathematics and medicine (STEMM) employment in higher education and research. As recognition of our commitment we were granted a Bronze Athena SWAN award in 2017.

ECU GENDER CHARTER
Athena SWAN
Bronze Award

The Botanic Gardens and The University of Glasgow

The Botanic Gardens have been part of the Glasgow city for 200 years and share close ties with the University of Glasgow. The Royal Botanic Institution of Glasgow by Royal Charter and the Botanic Gardens were founded in 1817 by Thomas Hopkirk, a prominent Glasgow Botanist, with support from the University of Glasgow. The Gardens provided the University with teaching aids, including a supply of plants for medical and botanical classes. The present site of the Botanic Gardens at Kelvinside, was established in 1842. The famous Kibble Palace which houses the national collection of tree ferns was moved to the Botanic Gardens in1873. Since 1891, Botanic Gardens are managed by the Glasgow Corporation and maintain close links with the University of Glasgow.

In 1820 Sir William Jackson Hooker became the Regius Professor of Botany at the University of Glasgow. He contributed hugely to the development of the Botanical Gardens and the Botany Department at Glasgow University for 20 years. The Hooker Chair of Botany is named after him. Professor Richard Cogdell the present Hooker Chair of Botany at University of Glasgow is Fellow of the Royal Society of London and an acclaimed botanist whose research on light-harvesting protein complexes has revolutionised our understanding of photosynthesis in bacteria.

The Glasgow Botanical Garden and the Kible Palace on a sunny day! (Photos by Rucha Karnik)

The Plant Science Group from University of Glasgow. Photo taken at the Main Entrance
of the Bower Building on 4th May 2017.

Book concept, design and editing was done by **Dr Rucha Karnik**. Rucha is a Royal Society University Research Fellow in the Plant Science Group at the University of Glasgow. She actively promotes plant science outreach and women in science.
See: http://www.gla.ac.uk/researchinstitutes/biology/staff/ruchakarnik/
Special thanks to David Chapman, Royal Society Public Engagement Manager for his advice on the making of this book.

All the doodle art in this book is created by **Dr Mathis Riehle**.

Page setting, design, social media publicity and building online resources for this book was handled by **Dr Maria Papanatsiou.** Maria is a postdoctoral researcher in the Plant Science Group at the University of Glasgow and she actively engages in research outreach.
See http://psrg.org.uk/

Mathis is a Cell Engineer in the IMCSB at the University of Glasgow and researches tissue engineering on nerve repair & biomaterials as well as teaching in biology. Mathis converts his passion for science into beautiful doodle art which he draws as he listens to scientific presentations. Mathis' doodles capture the jist of the science in a simple and attractive manner.
Details about Mathis can be found at: http://www.uofgcce.org
Blog: http://bio-mat-sketches-mor.blogspot.co.uk/
Twitter: @morenorse

All the group leaders within the The Plant Science Group contribiuted the contents for their research profiles. They acknowldege **Ms Claire Osborne**, IMCSB Administration for organising the printing of this book. Printing was carried out by the Print Unit from University of Glasgow.

Art on the book cover was created by **Mr Ally Wallace**.
Ally is an artist based in Glasgow. He works across a range of disciplines including, painting, sculpture and video to create artworks in response to chosen locations. This piece of art entitled "Agar Plate 2' was created by during 2014-2015 when Ally was Artist-in-Residence in the Bower Building at the University of Glasgow.

Details at http://www.allywallace.co.uk/

Institute of Molecular, Cell & Systems Biology

@UofGIMCSB

Contact us: ugplantsci@gmail.com

Plant Science Group
Bower Building
University of Glasgow
University Avenue
Glasgow G12 8QQ