Plant Research Unit
of the University of Dundee

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The Plant Research Unit of the University of Dundee continues to thrive at SCRI. It is now part of the newly formed College of Life Sciences following the restructuring of the University from seven Faculties to four Colleges. This change in academic structure and management will enable the University to continue to build on its recent successes in a rapidly changing and competitive environment. The College is a world ranking research centre and the only 5 biological sciences grouping in Scotland. The College employs over 650 scientists and support staff, including 68 principal investigators, from 49 countries working in state of the art facilities on the city campus. The University's Plant Research Unit located at SCRI currently has 25 people (plus visiting scientists) working in five research groups. Collectively, the Unit published over 30 papers in 2006 and won nine new research grants. The Unit is increasingly working in close collaboration with SCRI researchers and joint grant applications totaling over £3.2 million were submitted in 2006. The main activities of the Unit's five research groups during 2006 are summarised below.*

Genome evolution and biodiversity in crop plants (Dr Andy Flavell) Crop genomes have been selected from wild progenitors by thousands of years of human selection, leading to a big reduction in biodiversity. The Flavell group has developed high throughput molecular marker methods to measure this diversity, using polymorphism both at single nucleotides (SNPs) and in transposable element insertion positions. These marker approaches

are being applied to the improvement of fungal resistance in wheat and potato, in partnership with SCRI (Robbie Waugh, Glenn Bryan) in the EU Framework 6 Project BIOEXPLOIT (joint value to SCRI/UoD £1.25 million). Andy Flavell is also closely collaborating with David Marshall and colleagues at SCRI to refine the GERMINATE database for storing, manipulating and displaying data related to plant biodiversity. This work is supported by the BIOEXPLOIT project and a new BBSRC Project grant, GERMINATE 2, which commences early in 2007. The Flavell group is also analysing biodiversity of pea (*Pisum sativum*) in the EC Framework Project GRAIN LEGUMES. Finally, Andy Flavell and Robbie Waugh have co-supervised the PhD project of Maura Lyons to identify Miniature Inverted Repeat transposable elements (MITEs) in the barley genome. Maura submitted her PhD in September 2006.

Manipulation of plant metabolism by reverse genetics (Dr Claire Halpin) Current approaches to metabolic engineering in plants have several drawbacks. Most work to date has concentrated on modulating the expression of single genes and available procedures for coordinately manipulating multiple genes are arduous and time-consuming. Transgenic technologies are still imprecise and it is currently impossible to directly target a transgene to a specific genomic location or to perform 'gene-knockouts' in higher plants. Claire Halpin's group is interested in developing strategies for achieving coordinate multi-gene manipulation and gene targeting in plants, focussing particularly on manipulation of the lignin biosynthetic pathway. A recent grant from The Leverhulme Trust is funding continuing research into homologous recombination and gene targeting in the Halpin lab. Also in 2006, Claire Halpin, in collaboration with SCRI researchers (Robbie Waugh, David Leader and Derek Stewart) submitted several proposals to BBSRC to allow her to expand her lignin research into barley.

Plant ecophysiology and adaptation to environmental stress (Professor Lyn Jones) Environmental stresses such as drought and salinity limit agricultural production over a large proportion of the world's land area. Research in Prof. Lyn Jones's group aims to understand the ways in which plants can tolerate individual environmental stresses such as drought and salinity as a basis for improving both the genotypes available for agriculture and for improving crop management for stressful conditions. A particular thrust of the research in the past few years has been the development and refinement of remote sensing techniques for diagnosing and monitoring plant responses to various environmental stresses. Techniques being developed range from those applicable at the single leaf or plant scale through to regional sensing by means of airborne or satellite-based remote sensing. The work has a particular focus on novel approaches to the use of thermal imaging as a tool for assessing the rate of water loss from plant canopies and as a sensitive tool for drought 'phenotyping'. Lyn Jones outlines the potential of thermal imaging as a tool for the diagnosis and monitoring of plant responses to environmental stresses, especially drought, in the following article.

Resource availability ('Bottom up') effects on the functioning of photosynthetic organisms (Professor John Raven FRS FRSE) John Raven's main research activities during 2006 have been in three distinct areas. (1) *Inorganic Carbon:* Work published in 2006 on the tropical and warm temperate marine green acellular macroalgal genus *Caulerpa* showed great diversity of inorganic carbon acquisition processes among the eight species studied. As yet unpublished work shows diversity with the marine diatom genus *Thalassiosira.* (2) *Photosynthetically Active Radiation (PAR):* Papers published this year have increased our understanding of the factors limiting the use of very low fluxes of PAR in photolithotrophic growth of two species of marine algae, and have extended John Raven's earlier work on limitations on where life based on photosynthesis could occur elsewhere in the universe rather than on Earth. (3) *Trace Elements:* Work published in 2006 examined a wide phylogenetic range of marine microalgae for the effects of the PAR for growth on the content of a number of trace elements; for some elements in some organisms very high quotas were found at the lowest PAR values tested. While these findings require further mechanistic examination to determine if the large quotas have functional (catalytic) significance rather than representing luxury accumulation, they clearly have important implications for the allocation of trace elements between seawater and cells at differ-

ent depths in the surface ocean. All of this work involved collaboration nationally and internationally.

Identifying the genes that control flowering time and understanding how they are regulated (Dr Gordon Simpson) One gene that strongly promotes flowering in different plants is Flowering Locus T (FT). *Arabidopsis* mutants that ectopically express FT flower early. Gordon Simpson's lab has successfully screened for mutants that flower early in the absence of FT. The aim of this study is to identify factors that work alongside or downstream of FT in the control of flowering. The isolated mutants show different responses to day-length and ambient temperature. Progress towards characterising these mutants is being made and in 2006 Stephen Holland, a student at Dundee University, won a fellowship from the Genetics Society to begin positional cloning of the genes disrupted in these mutants. Gordon Simpson's lab is already focussing on molecular and genetic studies to determine how an Arabidopsis RNA binding protein called FPA promotes flowering. With funding from the BBSRC, Dr Lionel Terzi and Dr Jacqui Marshall have joined the lab to study the RNA targets of FPA. They are applying new technology (RIP and CLIP) to Arabidopsis that involves the isolation of complexes of RNA binding proteins with their cognate RNAs formed *in vivo*. If successful, this technology will be valuable beyond the field of flowering as it would provide a means to directly identify the genes regulated by the many plant-specific RNA binding proteins of unknown function. Gordon Simpson was one of 10 young plant developmental biologists invited to a UK–China partnering meeting in 2006 from which collaborations in regulatory RNAs are being developed.