CELLULAR AND REGULATORY BASIS FOR EARLY PLANT ORGAN GROWTH

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A central problem in Biology is to understand how genes cause organs to grow to a specific shape and size. Plants are convenient to address this question because their overall growth results primarily from the increase in cell numbers and increase in the size of individual cells. In addition, understanding organ growth in plants offers a clear path to practical use through the rational manipulation of crop growth and yield. A major bottleneck for understanding plant growth, however, is that although we know several genes that control the overall size and shape of organs, we do not understand what processes these genes control within cells to result in a net effect on the total size and shape of organs.

We aim to answer this question, by studying the early stages of floral organ development in the model species, *Arabidopsis thaliana*. Unprecedented opportunities to address the question above arise from two recent developments. One is the establishment of methods that allow quantitative, 3D analysis of cell geometry and cell division in growing organs. Using these methods, the UK partner in this project has recently found that a key regulator of organ growth, called *JAGGED (JAG)*, has an unanticipated role in co-ordinating cell volume with cell division in developing organs. The second is the development of techniques for detection of all genes controlled by a given regulatory gene, at well-defined stages of organ formation, which can reveal the repertoire of cellular functions that are controlled by a regulatory gene. Our Brazilian and Dutch partners have been developing these methods and applying them to understand the role of genes that control floral organ development.

Taking advantage of the complementary expertise, resources and biological interest of the partners involved in this project, we will extend both approaches to a key set of genes that control plant organ growth: *JAGGED (JAG), AINTEGUMENTA (ANT)* and *CIN-TCP* genes. We will test whether the co-ordination between cell size and cell division is a key feature of targeted by these genes at the early stages of organ growth. We will also test whether these genes target specific steps in cell division and clarify how the activities of these regulatory genes are combined during organ growth. Finally, we will identify the sets of genes controlled by *JAG* and *CIN-TCP* genes in the early stages of organ development which will show to what extent the function of these genes overlap, and reveal the key cellular functions targeted by these genes to determine how the organs grow.

Flower of a wild-type Arabidopsis thaliana *plant.*

OBJECTIVES

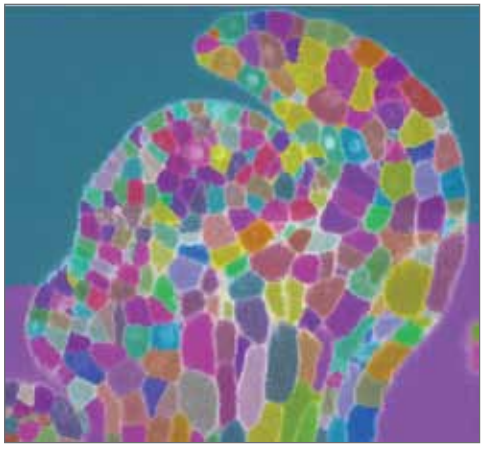
Work on this project is due to start in the second semester of 2012. Our work will benefit academics and industrial researchers working on the improvement of crop growth and yield. Computer modeling of plant growth is a very active research area at the moment and one of its main aims is to reveal the rules by which regulatory genes govern both localized and overall growth. A major limitation for making these models realistic and experimentally testable, however, is that we do not understand what cellular parameters (such as cell cycle progression or increase in cell mass) are growth limiting and targeted by growth regulators during normal development. Our project will directly benefit the field by addressing this important knowledge gap. In addition to essential knowledge on the control of plant organ growth, we will produce technical advances in quantitative imaging and image analysis with the potential to be adopted and widely used by the research community. Finally, by revealing which cellular processes are growth-limiting during normal development, we will facilitate the selection of candidate genes for improving crop growth and yield by conventional or transgenic approaches.

RELATED PUBLICATIONS

Dornelas MC, Patreze CM, Angenent G, Immink RGH. 2011. MADS: The missing link between identity and growth? *Trends Plant Sci.* **16**: 89-97

Sablowski R. 2011. Plant stem cells: from signaling to execution. *Curr. Opin. Plant Biol.* **14**: 4-9

Schiessl K, Kausika S, Southam P, Bush M, Sablowski R. 2012. *JAGGED* controls growth anisotropy and co-ordination between cell size and cell cycle during plant organogenesis. *Submitted*.



Quantitative analysis of cell growth and cell cycle: virtual section of 3D image of wt floral bud with combined segmentation (individual cells marked in random colours) and EdU labeling (cells with newly made DNA show white nuclei).

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