SYSTEMS BIOLOGY/ DOCTORAL TRAINING CENTRE

First Year Project Proposal - 2010

Supervisor(s): **Project 1 (3rd May-16th July)**

Prof. Philip Maini, Dr Mark Fricker, Dr Alex Fletcher, Dr James Osborne, Dr Vicente Grau and **Dr Boguslaw Obara**

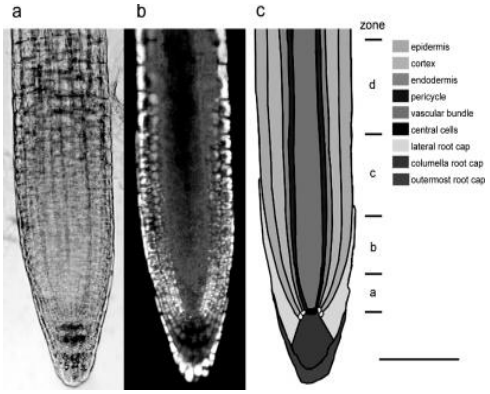
Title of Project / Field of research:

Modelling redox control of cell proliferation and hair tip growth in the *Arabidopsis* root

Description of project / Current research interests:

One of the major properties that make biological systems different to non-living matter is that biological systems grow. This presents inherent challenges to mathematics and computation as virtually all of the applied approaches in these subjects have been developed in the context of physics and engineering, where growth is not an issue. Incorporating growth leads to novel mathematical and computational problems. A biologically tractable system which can allow us to develop such new approaches is the growing tip root.

The debilitating effects of adverse environmental conditions on plant growth and development are thought to result in part from enhanced formation of reactive oxygen species (ROS). An important adaptive response of plants to conditions that increase ROS is amplification of their antioxidant defenses. This implies that mechanisms exist to sense levels of oxidative stimuli and act to modulate the antioxidant pool size.



Patterns of glutathione labelling in intact Arabidopsis roots. Reproduced from [2].

The aim of this project is to investigate, using mathematical and computational modelling, how redox intermediates could act to provide a direct link between environmental stress and morphological adaptation through alterations in the patterns of cell division in the primary root apical meristem. This will involve the development of a vertex-based model of a growing root tip (initially in 1D, then 2D), in which growth properties depend on the cellular concentrations of key molecules involved in redox homeostasis, including glutathione and redox poise measured using confocal imaging of transgenic roGFP reporters.

Location: Centre for Mathematical Biology (Mathematical Institute), Department of Plant Sciences and Oxford e-Research Centre.

Any other specific points: Backgrounds: mathematical and computational modelling, cell biology, imaging techniques.

References:

1. R. Sanchez-Fernandez, et al. Cell proliferation and hair tip growth in the Arabidopsis root are under mechanistically different forms of redox control *Proceedings of the National Academy of Sciences of the United States of America* 94:2745-2750, 1997.
2. M.D. Fricker, M. May, A.J. Meyer, N. Sheard, N.S. White. Measurement of glutathione levels in intact roots of Arabidopsis. Journal of Microscopy 198:162-173, 2000.
3. A.J. Meyer, M.J. May and M. Fricker. Quantitative in vivo measurement of glutathione in Arabidopsis cells. *Plant Journal* 27:67-78, 2001.
4. M. Schwarzländer et al. Confocal imaging of glutathione redox poise in living plant cells. J. Microscopy. *231*, 299-316, 2008.

For more information, please visit: http://www.oerc.ox.ac.uk/research/iapsb