Identifying mechanisms for stem cell division plane orientation in plants

Supervisory team:
Main supervisor: Dr Jill Harrison (University of Bristol)
Second supervisor: Dr Thomas Gorochowski (University of Bristol)

Collaborators: Prof Mike Scanlon (Cornell University), Dr Adrienne Roeder (Cornell University), Dr Zachary Nimchuk (Chapel Hill University, North Carolina), Dr Laura Moody (University of Oxford)

Host institution: University of Bristol

Project description:

Plant shape is a primary determinant of plant productivity and yield, affecting light interception and photosynthesis. As plant cells are bound by a cell wall and cannot move, shape arises as an outcome of the plane new divisions in stem cells at the shoot tips, cell fate determination and subsequent cell growth. Flowering plant models such as Arabidopsis have complex tissue organizations that can mask cell division plane defects. There are many genes per gene family, which can make it hard to identify mutants. For these reasons, few genetic regulators of stem cell division plane orientation have been discovered.

In contrast to flowering plants, mosses have simple tissue organizations with a single stem cell at each growing point, and there are few genes per gene family. My lab has determined that the CLAVATA receptor-like kinase sets the plane of moss stem cell divisions [1, 2]. Although mosses are distantly related to flowering plants, our findings were transferable to Arabidopsis, and we are building a pipeline for knowledge transfer to improve yield by manipulating CLAVATA function in wheat [3]. This project feeds in at the fundamental end of the pipeline, aiming to harness the advantages of the moss model to reveal downstream effectors of CLAVATA function that determine the plane of stem cell divisions at plants' growing points. To this end the project will: 5. Identify downstream targets of CLAVATA by RNAseq and bioinformatic analysis 6. Generate mutants of a candidate target and analyse mutant phenotypes 7. Analyse gene regulatory network architecture using computational approaches 8. Identify novel cell division plane regulators using a suppressor screen.

By combining computational and wet lab approaches, the project will provide training at the cutting edge of the plant development field. It will benefit from further formal teaching and internships included in the SWBioDTP programme. The skills and techniques the student will learn will be broadly applicable in the academic biology and biotech sectors and widely transferable amongst areas such as science policy, publishing and computing.

[1] Harrison et al. 2009. Local cues and asymmetric cell divisions underpin body plan transitions in the moss Physcomitrella patens. Current Biology 19: 1-11. [2] Whitewoods et al. 2018. CLAVATA was a genetic novelty for the morphological innovation of 3D growth in land plants. Current Biology 28: 2365-2376. [3] Fletcher 2018. The CLV-WUS stem cell signaling pathway: a roadmap to crop yield optimization. Plants 7: 87.