

Offre de stage de Master / Master Internship offer

Host lab: Reproduction et Développement des Plantes (RDP, Dir. Teva Vernoux), ENS Lyon

<http://www.ens-lyon.fr/RDP/spip.php?rubrique19>

Supervision: Olivier HAMANT (Research director / DR2 INRA)

olivier.hamant@ens-lyon.fr, Tel : 04 72 72 88 75

<http://jobs.inra.fr/Nos-metiers/Portraits/Olivier-Hamant>

<http://www.slcu.cam.ac.uk/directory/hamant-olivier>

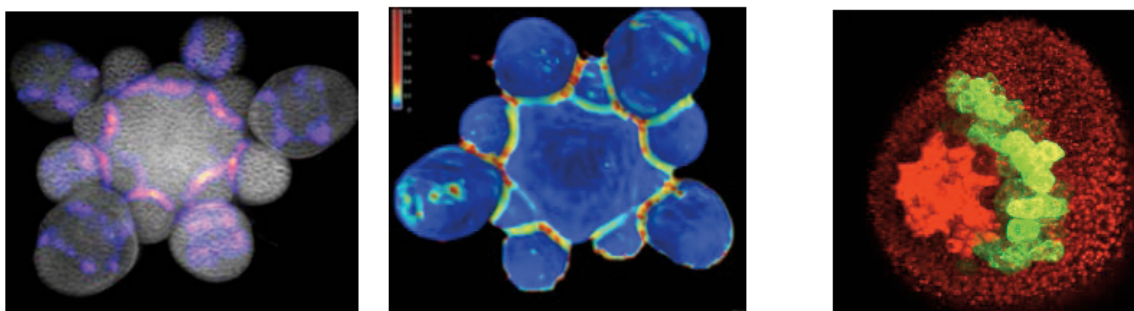
Research project title: The contribution of mechanical signals in shoot apical meristem functions

Project description:

Beyond gene networks and morphogen gradients, there is accumulating evidence that mechanical forces, originating from growth, also contribute to the developmental program (1-8). The host team has pioneered this field of study in plants, focusing on the shoot apical meristem (SAM), a group of dividing cells that is responsible for the production of all aerial organs. In the past years, we showed that mechanical stress in the meristem controls the behavior of microtubules (9) as well as the distribution of the plant hormone auxin (10), homeobox gene *STM* expression (11) and cell division plane orientation (12). We identified a mechanism in which differential growth induces mechanical stress and mechanical stress in turn further promotes growth heterogeneity (13). We also found that such mechanical feedback channel final organ shapes (14). In the future, we aim at 1/ relating these mechanical signals to established developmental pathway, with a focus on chromatin regulators and 2/ investigating the contribution of the structural elements of the cells and known mechanosensors in meristem functions.

In the frame of an ERC-funded project, we are already analyzing wall receptors (potentially involved in sensing wall integrity and stiffness, see 15,16), membrane composition (involved in microtubule anchoring and dynamics), and nuclear envelope (the main site of microtubule nucleation and relating cytoskeleton behaviour to chromatin changes, see 17). In this traineeship, we propose to analyze the synergies between these different actors and the known regulator of meristem functions. We have indirect evidence that some of the chromatin regulators involved in meristem activity are also downstream of mechanotransduction.

At the bench: This project involves molecular genetics and live imaging of meristems (confocal microscopy and evolved image analysis). Mechanical tests in the form of ablation and compression will be performed. In addition, recently developed lines expressing modified wall properties in sectors (Cre-Lox induced mosaics) will be used to generate mechanical conflicts. Because this project has many prospects, it can be developed later on in a PhD, in interaction with modelers and physicists in the lab and abroad (ongoing collaboration with the Sainsbury lab, Cambridge, UK).



Note 1: Three previous PhD students working on mechanical signals in the team:

- Benoit Landrein (2011-2014): 1st author papers: *Curr. Biol.* 2013, *J. Exp Bot* 2014, *eLife* 2015; co-author: *Cell* 2012, *Science Adv* 2016; Reviews: *Trends Pl Sci* 2012; *Plant J* 2013. Now postdoc in Cambridge, UK.

- Marion Louveaux (2012-2015): 1st author papers: *PNAS* 2016, *Plant J.* 2016, other in prep; co-author: *Front Pl. Sci* 2015; Reviews: *Curr. Op. Pl. Biol* 2013. Now postdoc in Heidelberg, Germany.

- Nathan Hervieux (2013-2016): 1st author papers: *Curr. Biol.* 2016, others in prep; co-author: *eLife* 2015, *Biophys J.* 2016, other in prep.; Review: *Plant biomechanics book chapter* 2017. Postdoc offer in Cambridge, UK and Stanford, USA.

Note 2: Invitation to publish a review on plant mechanosensing (BMC biology – due Jan. 2017) to which the recruited M2 student may contribute.

References:

1. Engler et al., *Cell* 126, 677 (2006);
2. Thery et al., *Nature* 447, 493 (2007);
3. Asnacios and Hamant, *Trends Cell Biol* 22, 584 (2012);
4. Shraiman, *Proc. Natl Acad. Sci. USA* 102, 3318 (2005);
5. Hufnagel et al., *Proc Natl Acad Sci U S A* 104, 3835 (2007);
6. Landsberg et al., *Curr Biol* 19, 1950 (2009);
7. Farge, *Curr Biol* 13, 1365 (2003);
8. Desprat et al., *Dev Cell* 15, 470 (2008);
9. Hamant et al., *Science* 322, 1650 (2008);
10. Heisler et al., *PLoS Biol* 8, e1000516 (2010);
11. Landrein et al., *eLife* 4:e07811 (2015) ;
12. Louveaux et al., *PNAS* in press (2016) ;
13. Uyttewaal et al., *Cell* 149, 439 (2012);
14. Hervieux et al., *Curr Biol.* 26, 1019–1028 ;
15. Ringli, *Plant Physiol* 153, 1445 (2010);
16. Wolf et al., *Annu Rev Plant Biol* 63, 381 (2012);
17. Hampoelz and Lecuit, *Development* 138, 3377-3386 (2011)