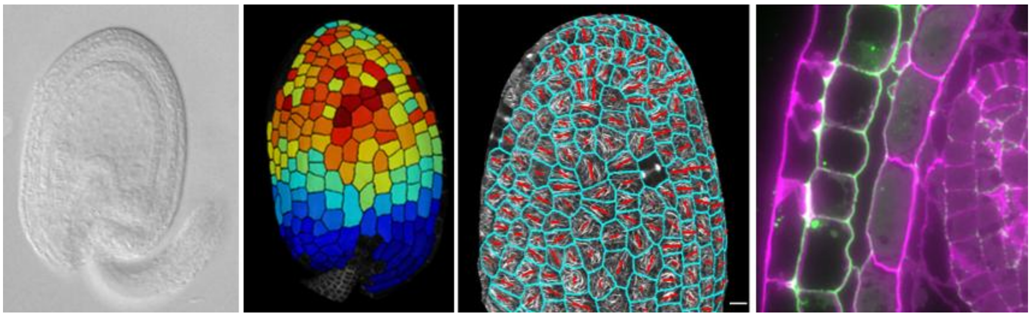
Master Internship offer (06/2025)

How does the endosperm control the growth of the seed in *Arabidopsis*?



Internship supervisor and Host laboratory:

Lab: Laboratory of Plant Development and Reproduction (RDP)
Team: Seed Development team (Leader: Gwyneth Ingram)
Internship supervision: Benoit Landrein (CR CNRS) & Gwyneth Ingram (DR CNRS)
Technical supervision: Audrey Creff (IE CNRS)
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Address of the internship: RDP, ENS de Lyon, 46 Allée d'Italie, 69364 Lyon Cedex 7
Team Website: https://www.ens-lyon.fr/RDP/developpement-de-la-graine/
Languages spoken in the lab: English and French

Project description:

The size and shape of plant organs result from mechanical interactions between cells and tissues. These interactions generate forces that can be sensed by cells, influencing key processes involved in growth and development (Braat and Landrein, 2025, *Current Opinion in Plant Biology*; Landrein and Ingram, 2019, *Journal of Experimental Botany*). Supporting this idea, the growth of Arabidopsis seeds depends on mechanical interactions between two physically and genetically distinct compartments: the endosperm and the seed coat. Specifically, our team recently proposed a mechanical model of the seed in which endosperm pressure directly promotes growth but also indirectly inhibits it by generating tension in the surrounding seed coat. This tension, in turn, promotes cell wall stiffening in the outer integument of the seed coat. By combining modelling and experimental approaches, we demonstrated that this model could explain both seed size (Creff, Ali et al., 2023, *Nature Communications*) and shape control in Arabidopsis (*Bauer et al., 2024, EMBO Journal*).

In plants, turgor pressure relies on the accumulation of small osmolytes (such as ions, amino acids and sugars) inside the cell, which promotes water influx, and the building up of turgor pressure. However, the molecular mechanisms that determine endosperm pressure are largely unknown. Interestingly, our team has recently shown that endosperm pressure is altered in *iku2*, a mutant in which the developing endosperm fails to polarize effectively to establish sub-domains with specific identities (i.e., chalazal, micropylar, and peripheral endopserm) (Creff *et al. in prep* and Creff, Ali et al., 2023, *Nature Communications*). This data supports that endosperm polarization is necessary for the correct building up of endosperm turgor pressure.

The goal of this internship is to study how endosperm polarity is determined downstream of *IKU2* and how this affects endosperm pressure and seed growth. To achieve this, the student will characterize the metabolic (*i.e.* osmolyte content), mechanical, and growth defects of mutants and transgenic lines impaired in endosperm polarity. This internship will involve generating *Arabidopsis* mutants and transgenic lines, followed by their phenotypic characterization using optical and confocal fluorescence microscopy, along with computer-assisted analysis (ImageJ, Gnomon). The project will also include biophysical approaches to measure endosperm osmolyte potential using an osmometer, and turgor pressure using a pressure probe and an indenter.

Lab publications:

Creff A, Ali O, Bied C, Bayle V, Ingram G, Landrein B. Evidence that endosperm turgor pressure both promotes and restricts seed growth and size. ***Nature Communications***. 2023 doi: 10.1038/s41467-022-35542-5

Bauer A, Ali O, Bied C, Bœuf S, Bovio S, Delattre A, Ingram G, Golz JF, Landrein B. Spatiotemporally distinct responses to mechanical forces shape the developing seed of Arabidopsis. **EMBO J**. 2024 doi: 10.1038/s44318-024-00138-w

Braat J, Landrein B. Mechanical control of plant organ growth: Lessons from the seed. **Curr Opin Plant Biol.** 2025. doi: 10.1016/j.pbi.2025.102737

Landrein B, Ingram G. Connected through the force: mechanical signals in plant development. **J Exp Bot**. 2019 doi: 10.1093/jxb/erz103