

Elucidation of new roles and components of the HAIKU2 signalling pathway in seed development

Seed development involves the concomitant and coordinated development of the products of double fertilization, the embryo and endosperm. In Arabidopsis, these structures both show a strongly polarized tissue organisation. A membrane-nucleus signalling cascade involved in early embryo polarity establishment has been identified, although the extracellular cues providing positional information upstream of this cascade remain unclear (1). Conversely, although the host lab has recently revealed that the very young embryo produces a peptide signal (PIPL7) that controls the subsequent polar development of the endosperm through activation of the HAIKU2 receptor-like kinase (Figure), the membrane-nucleus signalling cascade involved remains poorly understood (2). Intriguingly, the same downstream transcription factors regulate polarity establishment in the two structures.

AIM: In this project you will fully characterise an unpublished post-fertilization nuclear proliferation phenotype associated with loss of HAIKU2 function, and use this phenotype to test the hypothesis that known signalling cascade components involved in embryo polarity establishment could also be involved in the HAIKU2-mediated control of early endosperm development.

Objectives:

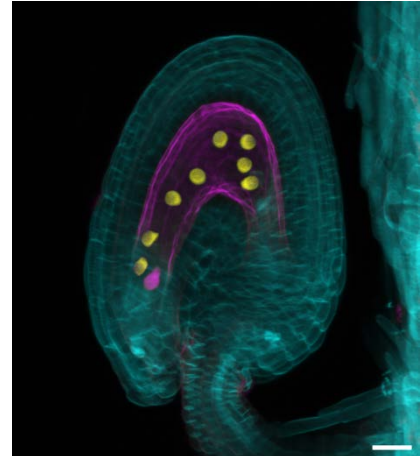
- 1) Streamline histological and fluorescent marker-based quantification of early nuclear proliferation.
- 2) Test the genetic basis for the nuclear proliferation phenotype observed in *haiku2* mutants: Does it depend on the maternal or gamete genotype? Is also present in mutant lacking the known HAIKU2 ligand PIPL7 (2).
- 3) Investigate whether mutants lacking five proteins (ERECTA, BSK1, BSK2, MPK6 and ICE1/SCRM) involved in signalling events occurring during embryo polarity establishment (1, 3) show similar nuclear proliferation phenotypes to those observed in *haiku2* mutants.

The project forms part of a collaboration with the group of Martin Bayer in Tuebingen University.

Techniques: Molecular verification of transgenic lines, histological and confocal microscopy techniques, image analysis and quantification, plant growth and genetic crosses.

References:

1. K. Wang, H. Chen, M. Ortega-Perez, Y. Miao, Y. Ma, A. Henschen, J. U. Lohmann, S. Laubinger, M. Bayer, Independent parental contributions initiate zygote polarization in Arabidopsis thaliana. *Curr Biol* **31**, 4810-4816.e5 (2021).
2. A. Creff, J. Rhodes, C. Salaün, J. Larive, V. Bayle, E. Turley, T. Nobori, D. D. Figueiredo, B. Landrein, C. Zipfel, G. Ingram, An embryo-derived peptide signal directs endosperm polarity in Arabidopsis. *Science* **393**, 1002-1008 (2026).
3. H. Chen, F. Xiong, A.-M. Wangler, T. Bischoff, K. Wang, Y. Miao, D. Slane, R. Schwab, T. Laux, M. Bayer, Phosphorylation-dependent activation of the bHLH transcription factor ICE1/SCRM promotes polarization of the Arabidopsis zygote. *New Phytol* **245**, 1029–1039 (2025).



Imaging nuclear gene expression markers in a seed 24 hours after fertilization: *HAIKU2* (yellow, endosperm nuclei); *PIPL7* (magenta, embryo nucleus). Counterstaining cyan, autofluorescence magenta.

Practical informations :

- Duration: 5-6 months (January-June 2027).
- Contact: The internship will be supervised by Gwyneth Ingram/Nathalie Fargeix/Audrey Creff in the RDP lab (ENS-Lyon) in the SeedDev research group. Please send a CV and a motivation letter to Gwyneth.ingram@ens-lyon.fr