HR EXCELLENCE IN RESEARCH

2021-04082 - Post-Doctoral Research Visit F/M Post--Doc in computational bio-physics applied to plant development

Contract type : Fixed-term contract
Level of qualifications required : PhD or equivalent
Fonction : Post-Doctoral Research Visit
Level of experience : From 3 to 5 years

About the research centre or Inria department

Grenoble Rhône-Alpes Research Center groups together a few less than 650 people in 37 research teams and 8 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

Context

Plants continuously develop at the tip of growing axes through the activity of the apical meristems. The genetic regulation of the shoot apical meristems (SAMs), which produce all plant aerial organs, has extensively been studied in the last decades. Various key molecular actors have been identified and their function in patterning the SAM has been mapped in space and time. According to recent works, these molecular actors not only regulate cell identities but also likely induce the physical deformation of tissues by modifying cell wall mechanical properties, in turn inducing leaf or flower primordia outgrowth. From these works progressively emerges a new mechanistic insight on the link between gene regulation, tissue deformation and organ growth in plants. However, despite these recent progresses, the contribution of turgor pressure and water fluxes regulation, that decisively contribute to tissue morphogenesis, is still elusive.

From a mechanical point of view, growth is powered by osmosis that tends to attract water inside the cells. The corresponding increase in volume leads to simultaneous tension in the walls and hydrostatic pressure (so-called turgor pressure) in the cells. Continuous growth occurs thanks to the yielding of the walls to these stretching forces. Plant tissues can be seen as a collection of such cells that all attract water from their environment through plasmodesmata (channels between cells) and aquaporins (proteins on their membranes connected to the extracellular space), respectively referred to as symplasmic and apoplasmic pathways. We have recently developed a 2D model of this system with a simplified description of the apoplasmic pathway, that already showed complex and interesting emerging properties linked to water fluxes, and helped to interpret experimental data.

Assignment

This previous work has opened new avenues that we want to explore with new experiments and a more realistic model in the context of the ANR project Hydrofield composed of biologists, biophysicists and modelers. New experiments from our collaborators will provide physical measurements such as local pressure, growth rate, membrane permeabilities; we'll have also access to the spatial and temporal expression of genes implied in the hydraulic properties of the cells; and finally, mutants or drugs will provide a way to alter the mechanical and hydraulic properties and constraint the model.

The goal for the postdoc will be to develop a model in order to be able to take into account experimental measurements and to

General Information

- **Theme/Domain :** Computational Biology
  Scientific computing (BAP E)
- **Town/city :** Lyon
- **Inria Center :** CRI Grenoble - Rhône-Alpes
- **Starting date :** 2021-11-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2021-12-15

Contacts

- **Inria Team :** MOSAIC
- **Recruiter :**
  Godin Christophe /
  Christophe.Godin@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

The candidate should have a solid background in bio-physics and/or computational biology. She/he should have strong and interdisciplinary communication skills at the interface between biology, biophysics, applied mathematics, and computer science.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

interpret them: 1) add a more realistic, spatially explicit, apoplasmic compartment, and 2) extend the initial 2D model to 3D in order to have a correct geometrical description of the meristem. In both cases, exploring the properties of the model and comparing it with experimental data will be an important part of the work.

Understanding the contribution of water fluxes may have a profound impact on our vision of morphogenesis. This will open for the first time the possibility to build up a view of plant development unifying the pressure forces that drive development, the material that resist to these forces, and at the center, the biological processes that locally regulate this developmental equilibrium.

References

- I. Cheddadi, M. Génard, N. Bertin, and C. Godin. Coupling water fluxes with cell wall mechanics in a multicellular model of plant development. PLoS Comput. Biol., 15, 2019.
- Y. Long, I. Cheddadi, G. Mosca, V. Mirabet, M. Dumond, A. Kiss, J. Traas, C. Godin, and A. Boudaoud. Cellular heterogeneity in pressure and growth emerges from tissue topology and geometry. Curr. Biol., 30, 2020.

Main activities

- Review of cell-based models of phyllotaxis and auxin transport
- Participating to meristem imaging and analysis with biologists
- Conception of models of phyllotaxis at cellular resolution
- Implementation of the models (python, C++)
- Paper writing and communication at conferences

Skills

Scientific skills: a PhD in applied mathematics with applications in computational physics/biophysics is the ideal profile. A PhD in physics/biophysics with experience in numerical modelling would also be adequate. Interest in biological systems and morphogenesis is recommended.

Technical skills: numerical methods (ODE/PDE), scientific programming (python, julia), interdisciplinary environment.

Remuneration

Salary: 2 653€ gross/month (income tax excluded).