



Offer #2024-07738

Post-Doctoral Research Visit F/M Post-doctoral position in mathematical and/or computational biology: Multiscale modeling of single cell-based dynamics of ovarian development

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris**.

The centre has [39 project teams](#), 27 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

Context

The postdoc position is open in the framework of the AI4scMED ("MultiScale AI for SingleCell-Based Precision Medicine") consortium (<https://ai4scmed.github.io>) of PEPR Santé Numérique (project no. 22-PESN-0002) headed by INRIA-INSERM, gathering researchers from different institutions on AI developments for single-cell biology applied to precision medicine.

The position is an opportunity to be involved in a strongly interdisciplinary consortium, and to strengthen experience in mathematical and computational biology by working on the embedding of single cell spatial data within a multiscale modeling framework.

The contract is expected to start between October, 1st and December, 1st 2024.

Assignment

The postdoc fellow is expected to use and develop the computational platform Simuscale (Bernard et al 2024) which enables one to simulate both intra- and extra-cellular processes at different time scales, and whose decoupled architecture allows for an easy and parsimonious extension of implemented models with e.g. a new kind of intra-cellular formalism.

A mechanistic Gene Regulatory Network (GRN) model based on a Piecewise Deterministic Markov Process (PDMP) formalism has been recently implemented in Simuscale. This approach has been shown to realistically simulate cell dynamics, including cell-cell interactions and cell fate decision-making, as well as simulating realistic single-cell transcriptomic data (Nguyen et al.2024).

A similar approach coupling cell population dynamics with GRN will be applied to ovarian development. Ovaries are highly dynamical organs subject to permanent remodeling, which is associated with the development of ovarian follicles, the basic functional and anatomical units of the ovary consisting of an oocyte (the future female gamete) and populations of somatic cells. Getting insight into the multiscale mechanisms underlying ovarian follicle development and their changes all along reproductive lifespan will be of great help for early diagnosis and management of ovarian aging. The development of oocytes within germline cysts was recently examined at the single cell level in the mouse (Niu & Spradling 2020). This study has illustrated the intricacy of the cellular and molecular levels, including key spatial aspects involved in the earliest steps of ovarian follicle development.

The postdoc fellow will implement in Simuscale a model for the formation of ovarian follicles, in order to integrate a molecular description at the single cell level into a spatially realistic model. The research project will focus on the selection of oocytes from precursor germ cells (Niu & Spradling 2020, Niu & Spradling 2022) and the formation of the pool of ovarian follicles with which female mammals are endowed once and for all at birth. From available scRNAseq data in litterature, a gene regulatory network controlling germ cell differentiation will be inferred. The GRN will be coupled with a spatial model of cell populations involving both germ cells and somatic cells, as the model already designed for the subsequent growth of ovarian follicles (Clément et al. 2021).

References

S. Bernard, F. Crauste, O. Gandrillon, C. Knibbe, and D. Parsons (2024). Simuscale: A modular framework for multiscale single-cell modelling. Technical Report RT-0520, Inria Lyon./hal-04400510
F. Clément, F. Robin, R. Yvinec (2021). Stochastic nonlinear model for somatic cell population dynamics during ovarian follicle activation. *J. Math. Biol.*, 82:12.
W. Niu and A.C. Spradling (2020). Two distinct pathways of pregranulosa cell differentiation support follicle formation in the mouse ovary. *Proc. Natl. Acad. Sci. U.S.A.*, 117(33) :20015–20026.
W. Niu and A.C. Spradling (2022). Mouse oocytes develop in cysts with the help of nurse cells. *Cell*, 185(14) :2576–2590.
T.N.T. Thao Nguyen, M. Martin, C. Arpin, S. Bernard, O. Gandrillon, F. Crauste (2024). In silico modelling of CD8 T cell immune response links genetic regulation to population dynamics. *bioRxiv*, doi: 2024.03.01.582928

Main activities

Review the literature
Design the models for cell population dynamics and GRN
Implement the models in the Simuscale environment
Interpret the model outputs
Write and disseminate the results to the scientific community

Skills

Technical skills

The applicant should have a PhD in mathematical or computational biology. Any complementary training in biology, mathematics, or computer science, will be a plus.

The applicant will have an experience in mathematical and/or computational biology and will be able to implement new and existing C++ codes. They should be able to share code through Git, and to use High Performance Computing facilities. In addition, the usage of various (deterministic, stochastic) mathematical formalisms, including agent-based models, and an experience in parameter estimation with experimental data will be considered as a plus.

Language: English (basic French notions may ease daily life)

Relational skills

Interdisciplinary meetings and research are at the core of the project, so it is expected that the Postdoc Fellow is comfortable with researchers from other fields. Good ability for team playing will be appreciated.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Monthly gross salary : 3.250 euros/month

General Information

- **Theme/Domain** : Modeling and Control for Life Sciences
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city** : Palaiseau / Paris
- **Inria Center** : [Centre Inria de Saclay](#)
- **Starting date** : 2024-11-01
- **Duration of contract** : 1 year, 6 months
- **Deadline to apply** : 2024-08-31

Contacts

- **Inria Team** : [MUSCA](#)
- **Recruiter** :
Clément Frédérique / Frederique.Clement@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

Before any application, please get in contact with [Chloé Audebert](#), [Frédérique Clément](#) and [Fabien Crauste](#)

Please provide a detailed CV - including names of the supervisors (of internships, PhD thesis, postdocs if relevant) as well as names and emails of 2 reference contacts - and a motivation letter.

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.

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.