

What is the ExposUM Doctoral Nexus?

PhD funding opportunities in Montpellier, France : ExposUM Doctoral Nexus

A Doctoral Nexus, as proposed by the [ExposUM Institute](#), brings together networks of three to four PhD students from diverse disciplinary backgrounds, affiliated with at least two distinct research units.

Unlike traditional PhD programmes, a Doctoral Nexus is designed to enhance collaborative skills and the ability to develop transdisciplinary projects, while allowing students to deepen their own field of expertise.

Nexus doctoral students will benefit from a dedicated training programme and will have the opportunity to organise seminars within their Nexus network.

The ExposUM Institute provides full funding for four years, covering both the PhD students' salaries and an environmental allowance.

The context of the thesis:

The proposed PhD thesis is part of a Nexus network of 5 researchers and 3 PhD students, working on a common theme: “The microbial **EX**posome and drivers of **PER**sisten**T** infections in humans: an interdisciplinary approach to understand the interplay between bacterial pathogens of environmental and zoonotic origins and the host innate immune system.” The Nexus project integrates experimental approaches and uses mathematical modelling to deconvolute the heterogeneity of host responses and to reveal the dynamics of processes that shape the establishment of persistent human infections.

Chronic infections caused by bacteria such as *Salmonella*, *Pseudomonas*, *Achromobacter*, and *Burkholderia* can be modeled as dynamical systems describing interactions between bacterial populations, immune cells, and their environment, leading to long-term persistence. Recent experimental techniques provide large, heterogeneous datasets at multiple scales. A key challenge is to integrate these data into coherent mathematical models to uncover underlying mechanisms and infer causal relationships.

In this thesis, we will develop structured partial differential equation models of bacterial persistence. A particular challenge for both simulation and machine learning is the high dimensionality of these equations, which leads to the failure of mesh-based numerical methods and calls for the development of novel approaches.

Planned start date: 10/01/2026

The title of the doctoral student's position: Mesoscale mathematical modelling of bacterial persistence

Main mission: Develop and analyze structured partial differential equations models to investigate the mechanisms driving bacterial persistence in chronic infections (Salmonella, Pseudomonas, and Achromobacter) by integrating spatial modelling, single-cell transcriptomics, advanced imaging data, and machine learning approaches. The goal is to identify common and pathogen-specific mechanisms of persistence and to generate quantitative predictions supporting experimental studies.

Activities: • Develop three pathogen-specific mesoscale models based on structured partial differential equations (PDEs).

- Construct a unified modelling framework describing:
 - Spatial tissue dynamics (gradients, chemotaxis, cell–cell interactions).
 - Macrophage polarization (M1–M2 continuum and activation states).
 - Bacterial phenotypic heterogeneity (replication, dormancy, intracellular survival).
- Integrate single-cell transcriptomic data to build molecular dynamical models of macrophage polarization and host response.
- Incorporate quantitative microscopy data to estimate parameters related to:
 - Bacterial localization (intra-/extracellular),
 - Replication dynamics,
 - Infected macrophage populations.
- Perform parameter estimation using optimization and machine learning approaches.
- Develop numerical schemes for high-dimensional structured PDEs (pseudospectral methods, meshfree/particle approaches).
- Conduct sensitivity analysis and model reduction to identify key drivers of persistence.
- Use models to simulate in silico scenarios (immune modulation, relapse, clearance vs persistence thresholds).

Expected skills and qualifications:

Essential

- Strong background in applied mathematics, mathematical biology, or computational modelling.
- Experience with partial differential equations (PDEs) and dynamical systems.
- Programming skills (Python, MATLAB, or equivalent).
- Interest in quantitative modelling of biological systems.
- Ability to work with interdisciplinary data (omics and imaging).

Desirable

- Experience with:
 - Structured population models,
 - Multiscale modelling,
 - Numerical analysis of PDEs,
 - Machine learning for parameter inference,
 - Model calibration and sensitivity analysis.
- Familiarity with systems biology, immunology, or host–pathogen interactions.
- Experience handling transcriptomic or imaging datasets.
- Strong scientific writing and communication skills.

Diploma/field required: Master 2 / Applied Mathematics, Computational Physics, Computational Biology

Key words: Mesoscale modelling; structured PDEs; host–pathogen interactions; bacterial persistence; computational immunology;

CNU section to which the applicant belongs: 26, 28, 29, 64

Application procedure

The application must include the following

- A CV
- A motivation letter
- The most recent transcripts from Master 1 and Master 2 (semester 1 and/or semester 2)
- Names and coordinates of 2 referees



If you would like to apply for this position, please send an e-mail to the thesis director Ovidiu Radulescu <mailto:ovidiu.radulescu@umontpellier.fr>+ co-director Anne Blanc-Potard anne.blanc-potard@umontpellier.fr, and exposum-aap@umontpellier.fr to inform them of your interest.

Application deadline : Before may 4th, 2026



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KEY FIGURES



RESEARCH CENTERS

From space exploration and robotics to ecological engineering and chronic diseases, UM researchers are inventing tomorrow's solutions for mankind and the environment. Dynamic research, conducted in close collaboration with research organizations and benefiting from high-level technological platforms to meet the needs of 21st century society.

The UM is committed to promoting its cutting-edge research by forging close links with local industry, particularly in the biomedical and new technologies sectors.

More Information: <https://www.umontpellier.fr/en/recherche/unites-de-recherche>

SCIENTIFIC APPEAL

Open to the world, the University of Montpellier contributes to the structuring of the European higher education area, and strengthens its international positioning and attractiveness, in close collaboration with its partners in the I-SITE Program of Excellence, through programs adapted to the major scientific challenges it faces.

More Information: <https://www.umontpellier.fr/en/international/attractivite-scientifique>



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