LABORATOIRE INTERDISCIPLINAIRE
DES ENVIRONNEMENTS CONTINENTAUX

Job vacancy (36 months-PhD Position)
Immune dynamics in bivalves exposed to psychotropic drugs: a multi-scale evaluation resolved by photonic fluorescence techniques and use of bacterial reporters

- **Type:** 36-Month PhD scholarship.
- **Start Date:** October 1st, 2026 (expected).
- **Location:** Université de Lorraine-CNRS, Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC, UMR 7360 CNRS), Research Groups *Physical Chemistry and Reactivity of Surfaces and Interfaces* (PhySI) & *Stress Ecology* (ECOSE), Vandoeuvre-lès-Nancy / Metz, FRANCE.
- **Webpage :** https://liec.univ-lorraine.fr/

Context

The presence of pharmaceutical compounds in aquatic ecosystems has become a major environmental and public health concern. Despite their proven ubiquity, these contaminants, including antidepressants and other psychotropic drugs, frequently escape regulatory chemical monitoring. Current assessment methods often rely on "point-in-time" sampling, which fails to capture the complex chemical speciation of these hydrophobic compounds or the dynamic nature of organism exposure.

Among these substances, Selective Serotonin Reuptake Inhibitors (SSRIs), such as Sertraline (SER), are of particular interest. In non-target aquatic organisms like bivalves, serotonin acts as a key neuro-endocrine messenger regulating essential physiological functions, including growth, reproduction, and immunity. While the immunotoxic effects of such molecules are suspected, the underlying mechanisms remain poorly understood. Conventional ecotoxicological assays typically provide a "black box" view of immune health (e.g., measuring the final percentage of phagocytosis) but lack the spatial and temporal resolution required to identify early recognition signals or the specific subcellular pathways being disrupted. Accordingly, there is a critical need to bridge the gap between macroscopic physiological observations and the fundamental biophysical processes occurring at the cell level.

Project Description

The **PHOBIA** project (Photonics and Biosensors for Aquatic Immunotoxicology) proposes an innovative, multi-scale evaluation of the immune dynamics in the freshwater bivalve *Dreissena polymorpha* (the zebra mussel) when exposed to psychotropic stress. The project moves beyond traditional endpoints by utilizing advanced photonic fluorescence techniques and bacterial biosensors to resolve the immune response in real-time following *in vivo* and *ex vivo* exposure to sertraline.

The doctoral research is structured around three integrated axes:

Axis 1: Population-Scale Dynamics & Biosensing. The candidate will utilize bioluminescent bacterial biosensors to monitor the kinetics of the immune response. By measuring the light decay of "reporter" bacteria as they are ingested and killed by hemocytes (immune cells), the functional immunocompetence of the organism will be quantified in a high-throughput format. This will be complemented by flow cytometry to assess cell viability and global phagocytic capacity across different sertraline exposure scenarios.

Axis 2*:* Cellular-Scale Spatiotemporal Resolution of the Immune Response. This axis aims to move beyond static "point-in-time" measurements of immunity by providing a high-resolution, real-time view of the phagocytic process. While traditional methods can only confirm if a cell has eventually ingested a particle,

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this work package utilizes Confocal Laser Scanning Microscopy (CLSM) in time-lapse mode to resolve the precise dynamics of how hemocytes -specifically granulocytes, which are the sub-population with the highest phagocytic capacity- interact with bacterial pathogens.

Axis 3: Subcellular Mechanisms & Metabolic Stress. At the finest scale, the candidate will employ Fluorescence Lifetime Imaging Microscopy (FLIM) and dedicated functional fluorescent probes. This will allow for the monitoring of internal physiological parameters within a single living cell, such as lysosomal pH, reactive oxygen species (ROS) production, and mitochondrial activity. By mapping these variables, the project will decipher the metabolic cost of sertraline stress and how antidepressants interfere with the intracellular signaling pathways required for successful bacterial pathogen elimination.

Role of the PhD Candidate

The doctoral student will be the "keystone" of this multi-site and highly interdisciplinary project, bridging the fields of ecotoxicity and biophysics. Working within a collaborative consortium, the candidate will benefit from an environment where interaction goes far beyond simple periodic meetings, involving active daily support from researchers and technical staff. A primary focus of the position is the candidate's professional development and technical empowerment. The PhD student - depending on her/his backgrounds and needs - will undergo a comprehensive personalized training program covering all the advanced techniques utilized in the project:

Biophysics and Photonics: Theoretical and practical formation on fluorescence principles (continuous and pulsed excitation) and the operational mastery of CLSM (Confocal Laser Scanning Microscopy) and FLIM (Fluorescence Lifetime Imaging Microscopy).

Microbiology and Biosensors: Training in the engineering and use of bacterial reporters (*lux* and *gfp*) to monitor real-time biological interactions.

Ecotoxicology: Advanced training in flow cytometry and the design of *in vivo* and *ex vivo* exposure protocols.

As the candidate gains autonomy through this training, she.he will take the lead in perfecting experimental protocols, steering data acquisition phases, and managing high-resolution image processing. Ultimately, the candidate will play a pivotal role in the critical analysis of results and their dissemination within the international scientific community through publications and conferences. The consortium has already demonstrated the feasibility of the proposed approach and optimized sample preparation protocols to ensure a smooth transition to the PHOBIA project. The candidate will directly benefit from this extensive preliminary work conducted by the consortium.

Selection Criteria

- Background: Master’s degree in Ecotoxicology, Biophysics, or Biophysical Chemistry.
- Technical Skills: Knowledge of fluorescence microscopy, cell biology, an/or microbiology.
- Language: Skills in English (oral and written) are required.
- Personal Qualities: Autonomy, strong organizational skills, and a taste for interdisciplinary research.

Scientific environment of the PhD candidate

The successful PhD candidate will join a multidisciplinary team at the Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC), collaborating with researchers in Metz and Nancy, France. This two-sites of the LIEC environment offers renowned expertise across ecotoxicology, microbiology, and (bio)physical chemistry. The work will involve luminometry measurements and experiments with state-of-the-art fluorescence microscopy and cytometry equipments. The candidate will benefit from the supervision by researchers and engineers from different scientific horizons ((bio)physical chemists, microbiologists, experimentators and theoreticians), thus offering her/him the possibility to acquire a

large panel of competences that could be decisive for her/his future academic or R&D career. The candidate will be **primarily located at the Metz campus** (Campus Bridoux). Due to the multisite and interdisciplinary nature of the PHOBIA project, the doctoral student will be required to make regular stays at the Nancy campus in Vandoeuvre-lès-Nancy. These two sites are located only 60 km apart. All transportation and logistical costs associated with traveling between the Metz and Nancy sites of the LIEC laboratory for project activities will be fully funded by the laboratory.

To be successful, the candidate should demonstrate one or several of the following skills:

- Possess a background in ecotoxicology and/or biophysical chemistry,
- Have a solid experience in cell culture preparation and cell biology,
- Be results-driven, have a marked sense of autonomy and scientific curiosity while being eager to work in a dynamic and interdisciplinary team,
- Able to manage deadlines,
- Have good communication skills (both oral and written) in English (knowledge in French is not required),
- Competence in programming (Fortran, Matlab, etc.) and Image Processing (FIJI, etc.) would be strong added values to the application of the candidate.

Education/Experience:

- Master in ecotoxicology or biophysics. Knowledge in Physical Chemistry and/or Applied Mathematics, and/or Numerical Programming would be a strong asset. French candidates with diploma from Engineering Schools in biology, biotechnology, (bio)chemistry and/or (bio)physics are also eligible for the PhD position.

Remuneration

ca. 1800 (net) €/month.

Applications to submit:

Candidates are requested to submit a written application comprising:

1. A letter that addresses one or several of the Selection Criteria set out in the Position Description.
2. An executive summary (no more than approximately 1000 words) that highlights your strengths and reasons why you should be appointed to the position.
3. Your CV.
4. Recommendations letters by at least two referees, including their contact details (emails and phone numbers) and positions.
5. Your Master 2 or final-year Engineering School transcripts of records.

Supervisors of the Doctoral fellowship:

- Prof. Jérôme F.L. Duval (https://scholar.google.fr/citations?user=HiVen9QAAAAJ&hl=fr&oi=ao & https://duvaljfl.webnode.fr/).
- Dr. Laetitia Minguez (https://scholar.google.com/citations?user=2Bj-zWoAAAAJ&hl=fr).

Complete applications should be sent to Laetitia Minguez (laetitia.minguez@univ-lorraine.fr) and Jérôme F.L. Duval (jerome.duval@univ-lorraine.fr) before **June 1st, 2026**. In addition, applications must be submitted via the **ADUM platform** (https://adum.fr) also before **June 1st, 2026**.