Post-doctoral position at LGC Toulouse - ANR PROJECT MIMEBIOTIC

Simulation of mass transfer and reaction kinetics in a hydrogel supported on membrane into an innovative bioreactor

Duration: 18 months
Starting date: May-June 2026

Keywords: **hydrogel, membrane, cell growth, transfer, simulation, millifluidics, intensification**

Context: The **MIMEBIOTIC project (https://lgc.cnrs.fr/les-projets/projet-mimebiotic/**) aims to propose an innovative and sustainable strategy for intensifying bioprocesses by developing a bioreactor based on a membrane-supported hydrogel. By **immobilising cells in membrane-supported hydrogels (MSH)**, we can take advantage of a number of **levers to increase productivity: cell densification, maintenance of optimal physiological conditions (particularly if the metabolite is inhibitory), compactness and ease of scaling up** thanks to the use of hollow fibre membranes (by multiplying the modules) [1-3].

The Material and Membrane Process team at LGC (Toulouse, France) has developed a well-established expertise on membrane modification and membrane characterization. This team works in collaboration with an expert in mass transfer in millifluidic and microfluidic devices at the LGC and experts in microbiological and cell culture engineers in Toulouse Biotechnology Institute (TBI). In this project, we will focus on the design of a MSH to immobilize and densify microorganisms of interest for bioprocess intensification and use it to study transfers and kinetics for bioproduction purposes.

The aim of the present position is to simulate flows, mass transfers and microbial kinetics in a millifluidic device which hold the MSH.

The coupling between i) the flows (external and permeation through the hydrogel loaded with cells and the membrane), ii) the mass transfers of the species of interest (nutrient, O_2, products formed, cell density, ...) and iii) the reaction kinetics of the microorganism (obtained by a TBI research engineer/or TBI team) within this model system will be modelled using Comsol Multiphysics software. The hydrogel and the membrane will be modelled as porous domains characterized by their effective transport (effective diffusion coefficients and permeabilities from first experiments) and microbial kinetics within hydrogel (obtained in TBI). The full coupling problem, involving relevant species (outside the cells such as substrate, O_2, products formed, etc.), will be solved.

Complementary filtration experiments using a millifluidic device will be carried out to validate the models obtained from simulations, optimize the hydrodynamic operating conditions, and increase the production rate. These experiments will also make it possible to tune the properties of the MSH to meet the final objectives and to provide input for the development of a larger-scale model.

Profile:
Applicants are expected to hold a Ph.D. with expertise in simulation and/or experiments in the field of membrane science including mass transfer and reaction (bio)kinetics and scale up of processes, preferably in the case of bioprocesses. Additional experience in micro/millifluidics and microscopy would be a plus as well as having already used the Comsol software. The applicant should have the motivation and enthusiasm to lead the project from fundamental research to application. S/he should be able to work in a multidisciplinary team in collaboration with chemists, microbiologists and engineers in the lab or outside.

S/he will work in collaboration with another PhD student and a research engineer within the same project and will probably supervise undergraduate and/or graduate students. French spoken is a plus but not mandatory.

A selection of applicants will be invited to a face-to-face or a Teams interview with a panel of three professors; who will question her/his motivation, skills, enthusiasm and vision.

Application:

Applications including a motivation letter, a comprehensive CV and the mail, address and phone number of two referees should be sent by March 20th, 2026 to Dr Clémence Coetsier and Dr. Fabien Chauvet

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Bibliography:

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2. Andersen, T., P. Auk-Emblem, and M. Dornish, *3D Cell Culture in Alginate Hydrogels.* Microarrays, 2015. **4**(2): p. 133-161.
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