

Research internship - CFD Simulations for the Design of Micro-Millifluidic Bioreactors for Organoid Culture

Record number : OPR-1211

Overview

RESEARCH DIRECTION

Antonio Alguacil Cabrerizo, Professeur -
Department of Mechanical Engineering

ADMINISTRATIVE UNIT(S)

Faculté de génie
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INFORMATION

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LEVEL(S)

2e cycle

LOCATION(S)

Campus de Sherbrooke

Project Description

PROJET

Organoids are tissue-engineered, in vitro cultured cell models that replicate many aspects of the complex structure and function of a corresponding in vivo tissue. They can be dissected and interrogated for fundamental mechanistic studies of human tissue development, regeneration, and repair, and can also be used for diagnostics, disease modeling, drug discovery, and personalized medicine.

Culture is achieved by immersing these organoids in wells, where a nutrient-carrying fluid slowly circulates in a laminar regime, feeding the cells and keeping the organoids suspended. However, significant challenges remain. The choice of well geometry influences cell nutrition and suspension, as well as the characteristic nutrient transport and diffusion times. These choices can lead to situations that should be avoided: if the suspension force is too weak, the cells touch the walls of the wells, resulting in a lack of nutrients. Conversely, if the flow becomes too strong, the shear forces cause mechanical damage to the organoids.

This internship aims to perform computational fluid dynamics (CFD) simulations of different bioreactor well geometries at different flow regimes, aiming to understand and identify optimal geometries and flow rates. Comparisons with previously conducted experimental studies will be used to validate the simulations.

The high-fidelity CFD solver Palabos (<https://palabos.unige.ch/>), based on the Lattice Boltzmann Method, will be used. It will enable unsteady simulations of complex three-dimensional geometries, thanks to the use of immersed boundary conditions.

TEAM AND ENVIRONMENT

The student will work within the research group of Prof. Antonio Alguacil Cabrerizo (antonio.alguacil.cabrerizo@usherbrooke.ca), in the Department of Mechanical Engineering, part of the Human Signal Acoustics Research Center (CRASH-UdeS). A close collaboration with Prof. Marc-Antoine Lauzon (Department of Chemical Engineering and Biotechnology Engineering) and Prof. Benoît Laurent (Department of Biochemistry and Functional Genomics, Faculty of Medicine) will be developed. The student will have access to advanced meshing, CFD simulation, and data post-processing tools. The student will have access to experimental measurements made within the new STEMUS platform.

QUALIFICATIONS

We are looking for a candidate (graduate level) with solid experience in computational fluid dynamics and programming skills

