

Projet doctoral en miroir
Mirror doctoral project



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INTER-DISCIPLINARY &
IN-LAB GRADUATE PROGRAM
UNIVERSITÉ DE MONTPELLIER

Intitulé du projet & acronyme <i>Project title & acronym</i>	<i>Designing remote-accessible bioelectronic cell systems for autonomous biomedical solutions</i> BIOREACH
Co-responsables scientifiques <i>Scientific co-directors</i>	<i>VENA Arnaud & CATTONI Diego</i>
Sujet de thèse 1 <i>Doctoral project 1</i>	Engineering and assembly of biohybrids for signal transduction integrating cellular biosensors with functional biopolymers
Directeur de thèse 1 * <i>PhD supervisor 1</i>	<i>CATTONI Diego</i>
UMR 1 <i>Research unit 1</i>	<i>Centre de Biologie Structurale (CNRS UMR 5048 - Univ. Montpellier - INSERM U 1054)</i>
École doctorale 1 <i>Doctoral school 1</i>	<i>Sciences Chimiques et Biologiques pour la Santé (CBS2, ED 168)</i>
Sujet de thèse 2 <i>Doctoral project 2</i>	Development and validation of conductive biopolymers for RFID interaction and integration with biohybrids
Directeur de thèse 2* <i>PhD supervisor</i>	<i>VENA Arnaud</i>
UMR 2 <i>Research unit 2</i>	<i>Institut d'Électronique et des Systèmes (CNRS UMR 5214 - Univ. Montpellier)</i>
École doctorale 2 <i>Doctoral school 2</i>	<i>Information, Structures et Systèmes (I2S, ED 166)</i>

PhD Topics and Expected Profiles

BIOREACH is an interdisciplinary doctoral project at the crossroads of synthetic biology, soft matter, and electronics. It aims to create remote-controlled bioelectronic systems by integrating genetically engineered bacteria with conductive organic polymers (COPs). These electrogenetic biohybrids will enable bidirectional communication with external radiofrequency (RF) signals, offering a powerful new platform for non-invasive diagnostics and therapeutic applications. The project is jointly led by the Centre de Biologie Structurale (CBS) and the Institut d'Électronique et des Systèmes (IES) in Montpellier, combining state-of-the-art biological engineering with advanced RF technologies. Selected PhD candidates will benefit from a vibrant interdisciplinary environment, access to cutting-edge research infrastructure, and international collaborations, including internships at the University of Tokyo.

Subject A – Chemical and biological sciences for health

Engineering and assembly of biohybrids for signal transduction integrating cellular biosensors with functional biopolymers

Required student profile:

This position focuses on the development of bacterial biosensors and the assembly of biohybrid systems capable of responding to RF-modulated stimuli. The ideal candidate should hold a Master's degree in bioengineering, molecular biology, synthetic biology, or biophysics, with a strong interest in interdisciplinary research. The PhD project includes engineering bacterial strains with custom biosensors, optimizing polymer-bacteria interfaces, and integrating biohybrids into electrogenetic platforms. The student will gain expertise in synthetic biology, microbiology, and advanced microscopy, and will work closely with the electronics partner at IES for device integration and validation.

Subject B – Information, structures and systems

Development and validation of conductive biopolymers for RFID interaction and integration with biohybrids.

Required student profile:

This position focuses on the design and characterization of conductive polymers for integration with biological systems. The candidate should hold a Master's degree (M.Sc., Ecole d'Ingénieur) with a background in electronics from DC to radiofrequencies, materials science, or applied physics, with a strong interest in biosensors and biomedical applications. The work will involve developing COPs responsive to environmental and RF-induced stimuli, designing new protocols for their electrical characterization (from kHz to GHz), and working collaboratively to embed these materials into functioning bacterial biohybrids. The student will have access to cutting-edge platforms for microfluidics and wireless system prototyping and will interact regularly with the biology team at CBS.

For more information about the project or the application process, feel free to contact us at diego.cattoni@inserm.fr / arnaud.vena@umontpellier.fr

Résumé/Abstract

The mirror doctoral project, BIOREACH, explores the design of bioelectronic systems capable of remote-controlled sensing and response, integrating genetically engineered bacteria with conductive organic polymers (COPs). These electrogenetic biohybrids aim to revolutionize biomedical technologies by enabling bidirectional communication for therapeutic and diagnostic applications. This innovative initiative addresses the limitations of current cellular control methods, such as optogenetics and sonogenetics, by leveraging RF technology, which provides deeper tissue penetration and non-invasive external control and biohybrids equipped with electroconductive biopolymers coupled to biosensors integrated in reprogrammed bacterial chassis for signal integration and output.

BIOREACH exemplifies interdisciplinary synergy, combining expertise in biophysics, synthetic biology, soft matter and electronics. The project unites two leading research groups: the Synthetic Biology Team at the Centre de Biologie Structurale (CBS), specializing in biohybrid engineering, and the RFID et Électronique Flexible Team at the Institut d'Électronique et des Systèmes (IES), renowned for its microtechnology and wireless communication expertise. Their collaboration spans the design of biocompatible conductive polymers, bacterial biosensors, and functional biohybrids, while pioneering methodologies for electrical characterization and system integration.

Two complementary PhD projects form the foundation of BIOREACH. The first focuses on engineering bacteria equipped with biosensors to respond to COP-induced signals, facilitating precise control over cellular functions. The second develops novel COPs with tunable properties to interact with electromagnetic waves and trigger cellular responses. Both projects emphasize a strong interplay between biology and electronics, fostering advanced interdisciplinary training through international collaborations, such as joint internships at the University of Tokyo.

This project will deliver transformative outcomes, including programmable biohybrid systems for real-time monitoring and therapy, high-impact publications, and patentable innovations. Beyond advancing biomedical applications, BIOREACH will train its PhD candidates with cutting-edge skills at the interface of biology and electronics, preparing them for leadership roles in academia and industry. This partnership not only enriches student training but also establishes a robust, long-term collaboration between CBS and IES, paving the way for innovative advances in remote-accessible biohybrid technologies.