Toulouse Biotechnology Institute
Bio & Chemical Engineering

**APPLIED RESEARCH INTERNSHIP OFFER – BIOLOGICAL PROCESSES**

**Optimisation of purple sulfur bacteria cultivation for CO2 removal by calcium carbonate bioprecipitation**

**Background:** In order to comply with the National Low Carbon Strategy (Stratégie Nationale Bas-Carbone SNBC) and France 2030/CarBioCem's goal of decarbonizing industry, it is necessary to develop carbon-free energy transformations and productions, i.e. not based on fossil carbon but on renewable carbon stocks – either biomass or gaseous carbon dioxide. Processes of CO2 transformation, whether of industrial or biogenic origin, are gaining popularity because of their potential aid against climate warming. At Toulouse Biotechnology Institute (TBI), work is already being done on the process of valorising CO2 into calcium/magnesium carbonates in the form of precipitates (solids). This transformation is achieved by a consortia enriched in anoxygenic purple sulfur bacteria (APSB). Potential of calcium/magnesium carbonation induced by microbial activity is already known and used to describe the natural formation of carbonate rocks within oceans and lakes (Bundeleva et al., 2014; Dupraz and Visscher, 2005; Pace et al., 2018; Shirokova et al., 2015).

**Internship subject:** This internship will be a part of Todor Ruzic's PhD project carried out at TBI, on the study of the selection and cultivation of APSB-enriched consortia and optimization of their potential to induce carbonate precipitation. Future work will be based on testing the consortia's ability to valorise and bioremediate by-products of construction industry. Cultivation in media with increasing mineral complexity will be carried out, before assessing the cultivation in leaching solutions sourced directly from the construction industry. Additionally, experiments based on the carbonation precipitation will be carried out, focusing on the optimization of several factors, including pH, EPS production, and experimental set-up variation (fed-batch and/or continuous mode).

Monitoring of the reactors will be based on various analytical techniques (spectrophotometric testing, ion chromatography, total organic carbon, chemical oxygen demand, etc.) and microbiology techniques (microscope observations, EPS colouring, fluorescence *in-situ* hybridisation, etc.). These analyses, supported by mass balances, will allow the characterization and comprehension of desired bacterial metabolism leading to carbonate precipitation. Microbial analyses should offer more insight into consortia evolution and APSB adaption to harsher cultivation conditions, along with uncovering the role EPS play in the carbonation phenomena.

Afterwards, obtained precipitates will be analysed under a scanning electron microscope and by X-ray diffraction (analyses carried out at the Geosciences and Environment Laboratory of Toulouse (GET), a partner of the project). Coincidently, potential of the precipitates to be included in cement production

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chain within construction industry will be evaluated as well (analyses carried out at the Civil Engineering team LMDC, a partner of the project).

This internship is offered for the 1st semester of 2027 for a period of 6 months. It is aimed at students in Master 2 or in the final year of engineering school. It will be exclusively experimental, with batch and chemostat bioreactor operation.

**Skills developed during the internship:**

- Scientific research approach
- Monitoring of microbial kinetics in batch and continuous reactors
- Knowledge of the phototrophic bacteria metabolism
- Knowledge of anaerobic cultivation
- Use of analytical equipment for chromatography, microscopy, biomass manipulation, etc.
- Writing scientific reports

**Profile sought: M2/ Bioprocess Engineering – Microbiological Engineering**

- A good theoretical knowledge of the operation of biological reactors would be appreciated
- Motivated to carry out research work.
- Curious and organized
- Knowledge of English language required

**Work environment:** The internship will be carried out within the SYMBIOSE research team (EAD9) within the TBI laboratory on the INSA-Toulouse campus. It will be directly supervised by Todor Ruzic (PhD student) and supported by a supervisory team made up of Matthieu Peyre Lavigne (CRITT-GPTE Research Engineer), Claire Dumas (INRAE Research Fellow and Head of the TBI Symbiose team) and Mathieu Spérandio (INSA-Toulouse Professor, Deputy Director of TBI).

**Keywords:** Bioreactors – Anaerobic Cultivation – Consortia Selection – CO2 – Purple Sulfur Bacteria

**Duration of the internship**: 6 months from February 2027 –

**Gratification**: gratification légale

**Interested?**

Send CV+ Cover Letter to ruzic@insa-toulouse.fr and mpeyrela@insa-toulouse.fr

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