Contrats doctoraux 2026

Titre du projet de thèse : Rationalized Genome Editing Platform in Marine Microalgae: Development of a Chemobiology (Click Chemistry) Strategy for Imaging-Based Quantification of CRISPR-Cas9 Complex Photoporation

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Résumé du projet de thèse (en 20 lignes maximum) :

Marine microalgae, such as Tetraselmis sp. and Nannochloropsis sp., represent a growing strategic interest within the field of blue biotechnology. Their ability to thrive in saline environments, combined with their capacity to fix atmospheric CO_2, makes them valuable biological models for fundamental research as well as for the production of biofuels and biosourced compounds (pigments, lipids, etc.). However, gene engineering approaches remain significantly hindered by the thickness and complexity of their cell wall, which acts as a major physical barrier and notably limits the use of the CRISPR-Cas9 genome-editing system. To date, biolistics remains the only transformation method available, yet its low transformation efficiency requires selective markers, thereby restricting the number of genes that can be edited.
To overcome this limitation, the project aims to develop a breakthrough transformation strategy by combining an innovative chemobiological and biophysical approach. The guide RNA of the CRISPR-Cas9 ribonucleoprotein complex (RNP) is specifically labeled with a fluorescent probe via bioorthogonal click chemistry, providing the first rationalized approach to delivery by enabling confocal imaging–based quantification of RNP uptake into cells. This real-time quantification will guide the physical optimization of photoporation, whose objective is to define laser parameters (intensity and pulse duration) that maximize the formation of efficient transient pores in the cell wall/membrane for RNP entry, while maintaining optimal cell viability.
The ultimate goal is to validate this high-performance interdisciplinary platform through its ability to achieve genome editing in marine algae. This advancement will provide the essential quantitative benchmark needed to accelerate gene engineering of marine bioresources (Hub 2).

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Remarques/commentaires supplémentaires :