Institut Microbiologie, Bioénergies et Biotechnologie
Aix*Marseille Université

PhD position

Engineering Picochlorum alga to understand giant virus infections and photosynthetic adaptability

Keywords

Picochlorum, CrispR/Cas9, photosynthesis, AMGs, viral infection

Summary of the project

Picochlorum, is an emerging model in microalgae biology. A member of the green algae clade (Trebouxiophyceae) and discovered as recently as 2004, a genome for P. SENEW3 was first published in 2014 and found to be one of the smallest (13Mb) and most gene dense (7K genes) within the eukaryote lineage (Henley *et al*., 2004; Foflonker *et al.,* 2014). Picochlorum is remarkably tolerant and has a rapid growth rate making it a good candidate to understand both adaptation to climate change and viral infection. Despite its industrial potential, much remains unknown about its photosynthetic reactions and metabolism. Furthermore the increasing number of picochlorum blooms in Mediterranean coastal lagoons are an environmental concern to oyster farming (Thau) impairing the growth of oysters, unable to consume the tiny alga. Understanding how picochlorum populations are regulated in nature, especially by viruses, is therefore of general public importance.

In an emerging collaboration between the BiAM and MIO labs postulating for this project, (already funded by AMU TRANSIVIR 2022-2025 project) we have isolated and sequenced a picochlorum, strain "Pico A", from the Berre Lagoon. We have also isolated a diversity of giant viruses that replicate in Pico A and a subset of these viruses have genomes containing two very ancient auxillary metabolic genes (AMGs) taken up from an algal host ancestor. These genes code for Heme Oxygenase (HMOX) and Phycocyanobilin:ferredoxin oxidoreductase (PCYA) a pathway that produces pigments in the algal chloroplast with important regulatory functions: increasing chlorophyll synthesis (Zhang *et al*., 2021), signaling the nucleus to produce antioxidants (Duanmu *et al.,* 2013) and stabilizing Photosystem I (Wittkopp *et al*., 2017). What use could a giant virus have with these enzymes? Do they modulate host cell metabolism during infection to increase replication efficiency? Make the infected host temporally more competitive within a population?

The main objective of our doctoral project is to adapt molecular biology and genetics protocols to Pico A with an aim to understand giant virus-microalgae interactions by manipulating HMOX and PCYA. The PhD candidate will also attempt to use an engineered CrispR/Cas9 Pico A as a chassis to engineer our giant viruses during infection (Noel *et al.,* 2021; Bisio *et al*., 2023). Picochlorum sp. has gained increasing interest as a source of renewable biomass due to its high resistance to temperature and salinity and unprecedented 2 hour doubling times. However, it's photosynthetic and heterotrophic metabolism remain almost completely uncharacterized and will provide one of the keys to understanding its adaptability. Thus our supporting aim within this project is to make a full photosynthetic characterization of the electron flows, photoprotection pathways and CO2 uptake mechanisms as well as to assess it capacity to grow on reduced carbon sources.

The co-supervisors

Xenie JOHNSON, Institut de Biosciences et biotechnologies d'Aix-Marseille – BIAM (Xenie.JOHNSON@cea.fr)
Guillaume BLANC, Institut Méditerranéen d'Océanologie – MIO (guillaume.blanc@univ-amu.fr)

Location

BIAM, CEA-Cadarache, Saint-Paul-lez-Durance, France
MIO, campus Luminy, Marseille, France

Doctoral school

Life and Health Sciences (ED 62), Aix-Marseille Université (https://ecole-doctorale-62.univ-amu.fr/)

Expected profile of the candidate

Molecular Biology, culture of photosynthetic organisms, analytical measurements, curiosity.

How to apply?

Send us a CV (specifying the English level), a cover letter, transcripts and ranking of Master degree (Master 1 and first semester of Master 2), and the contact information for at least two references by April 15th 2024.

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The candidate selected by the co-supervisors will be interviewed on June 4th 2024 by the Institute of Microbiology, Bioenergies and Biotechnology (IM2B) jury. Defense modalities will be given later.