Funded PhD project in Integrated Structural & Cell Biology in Grenoble, France

Title of the PhD project:
CO2NTROL: Remote control of gene expression by CO2 in green microalgae

PhD supervisors:
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Host laboratory:
Cell & Plant Physiology Laboratory (LPCV), SIGNAL team https://www.lpcv.fr/Pages/Signal/Presentation.aspx

Project summary:
Within the field of photosynthesis research, when talking about CO2 we mainly think it as the substrate for photosynthesis; much less is known about the signalling role of this gaseous molecule. In the proposed PhD proposal, we aim to unveil the signaling role of CO2 in a recently discovered pathway that controls light-responsive gene expression in the absence of light.
We will initially focus on the transcription factor (TF) CIA5 that acts at the crossroads of CO2 and light signalling. The PhD student will first perform experiments to reveal similarities and distinctions among carbon availability-, light- and CIA5 -related effects on transcriptome-wide gene expression (mRNA-seq). Chromatin Immunoprecipitation sequencing (ChIP-seq) will reveal regions bound in vivo by CIA5. The generated data will be integrated in statistical models to predict gene-regulatory interactions between TFs and putative targets; these interactions will be then experimentally validated at the cellular level by generating mutants with either altered TF binding sites or with deletions of selected TFs or their target genes.
This PhD project represents an interdisciplinary comprehensive approach expected to advance our knowledge of how microalgae respond to environmental cues from the molecular, gene and protein level to the cellular level.

Preferred skills: We are looking for highly motivated candidates with background in cell biology / molecular biology. Skills in bio-informatics and programming, or the willingness to get actively involved in such tasks will be highly appreciated.

Student role: The student will produce the data in the lab under the supervision of Dimitris Petroutsos and will analyze the ChipSeq under the supervision of Romain Blanc Mathieu. The computational work for inference of gene regulatory interactions from the integration of the heterogenous data will be conducted in collaboration with Zoran Nikoloski's lab at University of Potsdam and MPIMP. The student will be encouraged to spend two months of research sojourn to become familiar with the implementation of approaches and to further develop them in line with the proposed work.

Keywords:
Microalgae, *Chlamydomonas reinhardtii*, CO2 signalling, photosynthesis, transcription factors, acclimation dynamics, gene regulation.

Relevant publications of the team:

1. Lai X, Blanc-Mathieu R, GrandVuillemin L, Huang Y, Stigliani A, Lucas J, Thévenon E, Loue-Manifel J, Turchi L, Daher H, Brun-Hernandez E, Vachon G, Latrasse D, Benhamed M, Dumas R, Zubieta C, Parcy F. 2021. The LEAFY floral regulator displays pioneer transcription factor properties. Molecular Plant 14:829–837.
2. Arend M, Yuan Y, Omranian, N, Nikoloski Z*, Petroutsos, D. Widening the Landscape of Transcriptional Regulation of Algal Photoprotection. bioRxiv (2022) https://doi.org/10.1101/2022.02.25.482034.
3. Ruiz-Sola A , Flori S, Yuan Y, Villain G, Sanz-Luque E, Redekop P, Tokutsu R, Tsichla A, Allorent G, Arend M, Iacono F, Kueken A, Finazzi G, Hippler M, Nikoloski Z, Minagawa J, Grossman AR, Petroutsos D*. Photoprotection is regulated by light independent CO2 availability. BioRxiv (2021) https://doi.org/10.1101/2021.10.23.465040
4. Redekop P, Sanz-Luque E, Yuan E, Villain G, Petroutsos D, Grossman AR. Transcriptional regulation of photoprotection in the dark-to-light transition - more than just a high-light matter. BioRxiv (2021) https://doi.org/10.1101/2021.10.23.463292.
5. Petroutsos D, Tokutsu R, Maruyama S, Flori S, Greiner A, Magneschi L, Cusant L, Greiner A, Kottke T, Mittag M, Hegemann P, Finazzi F*, Minagawa J* (2016). A blue-light photoreceptor mediates the feedback regulation of photosynthesis. Nature, 537(7621), 563–566.