PHD PROJECT DESCRIPTION
(4000 characters max., including the aims and work plan to de published online)

Project title: Comparative screening and optimization of diverse microalgae strains for enhanced biomass and lipid productivity under CO_2-enriched cultivation systems

1.1. Project goals

The primary goal of this PhD project is to systematically evaluate and optimize a pre-selected panel of diverse and well-characterized microalgae strains for high-efficiency biomass production and lipid accumulation under controlled CO_2-enriched conditions.
The project benefits from immediate access to established strains, including:

- *Chlorella vulgaris*
- *Scenedesmus obliquus*
- *Spirulina platensis*
- *Dunaliella salina*

These will be complemented by additional robust freshwater green microalgae, such as:

- *Desmodesmus armatus* (high biomass productivity, stress tolerance)
- *Acutodesmus dimorphus* (formerly *Scenedesmus dimorphus*; strong lipid producer)

The project aims to:

- Compare biomass productivity across these strains
- Quantify their lipid accumulation and composition
- Identify optimal cultivation and stress conditions
- Select top-performing strains for CO_2 capture and bioproducts applications

1.2. Outline

This project leverages a ready-to-use strain collection, enabling immediate experimental work. The selected strains represent industrial relevance, physiological diversity, and resilience**,** ensuring both scientific and applied impact.
The research includes:

- Comparative cultivation of the 6 selected strains
- Growth kinetics and biomass productivity analysis
- Lipid profiling (neutral lipids, TAGs, fatty acids)
- Stress-induced lipid accumulation strategies
- CO_2-enriched cultivation experiments

The combination of proven industrial strains (*Chlorella*, *Scenedesmus*, *Dunaliella*, *Spirulina*) with emerging high-performance freshwater strains (*Desmodesmus*, *Acutodesmus*) increases the likelihood of identifying superior biomass producers.

1.3. Work plan

Year 1:

- Literature review and technical training
- Standardization of cultivation protocols for the selected microalgal strains
- Baseline growth and biomass productivity comparison
- Setup of CO_2 supplementation systems

Year 2:
- Optimization of cultivation parameters (light, nutrients, CO_2)
- Detailed growth kinetics across all the strains
- Initial lipid extraction and quantification
- Establishment of individual analytical pipelines (GC-FID)

Year 3:
- Stress-triggered induction of lipid accumulation in the selected microalgal cultures (nutrient limitation)
- Identification of top-performing strains with respect to biomass production
- CO_2 sequestration efficiency assessment

Year 4:
- Process modeling and productivity optimization
- Evaluation of industrial applications
- Publications and PhD thesis preparation

1.4. Literature (max. 7 listed as a suggestion for a PhD candidate preliminary study)

[1]. Calijuri, Maria L., et al. "Bioproducts from Microalgae Biomass: Technology, Sustainability, Challenges and Opportunities." *Chemosphere*, vol. 305, 2022, article 135508.
[2]. Liang, Ming-Hua, et al. "High-Value Bioproducts from Microalgae: Strategies and Progress." *Critical Reviews in Food Science and Nutrition*, vol. 59, no. 15, 2019, pp. 2423–2441.
[3]. Opia, A. C., et al. "Microalgae as a Sustainable Biofuel Source: CO_2 Fixation Mechanism, Lipid Extraction, Challenges, and Future Prospective. A Review." *Biofuels*, 2025, pp. 1–23.
[4]. Richmond, Amos, and Qiang Hu, editors. *Handbook of Microalgal Culture: Applied Phycology and Biotechnology*. 2nd ed., Wiley-Blackwell, 2013.
[5]. Zhang, S., and Z. Liu. "Advances in the Biological Fixation of Carbon Dioxide by Microalgae." *Journal of Chemical Technology and Biotechnology*, vol. 96, 2021, pp. 1475–1495.

1.5. Required initial knowledge and skills of the PhD candidate

- Background in biology, biotechnology, microbiology, or related field
- Basic laboratory and sterile techniques
- Understanding of metabolism and biochemistry
- Analytical and data interpretation skills
- Basic statistics
- Good English proficiency

1.6. Expected development of the PhD candidate's knowledge and skills

The candidate will gain:

- Advanced expertise in microalgae cultivation and physiology
- Experience in multi-strain comparative bioprocessing
- Proficiency in chromatography-based analytical techniques
- Skills in CO_2 utilization and sustainable bioproduction
- Strong scientific writing and publishing competence
- Interdisciplinary knowledge across biology, chemistry, and environmental engineering.