Astaxanthin Production by the microalgae *Haematococcus pluvialis*

Microalgae are photosynthetic organisms that convert carbon dioxide and light into high-value compounds (antioxidants, proteins, …) with applications in pharmaceutics, cosmetics, food, thereby contributing to the global bioeconomy (Acién Fernandez et al., 2021). They are mostly cultivated as suspended cells in conventional outdoor systems (closed photobioreactors - PBR and raceways, Fig. 1), but recently a new and promising approach has emerged to simplify biomass harvesting and improve productivity: the biofilm-based cultivation (Zhuang et al., 2018), in which cells adhere and grow on a support (Fanesi et al., 2022*; Li et al, 2024*). Biofilm technologies have proven to be more productive with a reduced environmental footprint (Penaranda et al., 2023). Among them, one can highlight the rotating systems, which are easily up-scalable and are mainly used for wastewater treatment (Yu et al, 2024).

Astaxanthin is one of the most interesting microalgae compounds, with applications in human and animal nutrition. It is usually produced in a two-stage suspended cultivation system (growth promoting or green stage followed by red stage in which the cell accumulates astaxanthin, Fig 1). However, improvements to the production process are needed to meet the growing demand for natural astaxanthin and reduce production costs. Interestingly, for the first time, astaxanthin production using *H. pluvialis* cultivated in a rotating biofilm reactor has been demonstrated at LGPM (Morgado et al., 2023*).

In the frame of this Master's internship**, the production of astaxanthin by *H. pluvialis* in suspended and biofilm-based systems will be investigated and compared**. The student will work in close collaboration with a PhD student.

Tasks: (1) After an initial bibliographic study, the student will set up dedicated reactors to cultivate *H. pluvialis* (suspended and immobilized). The effect of different light regimes on cell physiology (pigments content, photosynthetic activity, growth, …), biomass, and astaxanthin productivity will be studied. These experiments will also provide data to tune and validate a dynamic model predicting both biomass and astaxanthin production by *H. pluvialis* biofilm-based cultures.

Acquired knowledge and skills: theoretical and experimental knowledge on microbial cultures, microalgae and biofilms. Among the laboratory techniques that will be used: culture of microalgae, flow cytometry, chlorophyll fluorescence, and oxygen monitoring.

This project will be carried out in the Laboratory of Chemical Engineering and Materials (*LGPM, Bioprocess team*), CentraleSupélec/University Paris-Saclay, Gif-sur-Yvette.

Master's internship starting in March/April 2026.

Contact: Please contact Filipa Lopes (filipa.lopes@centralesupelec.fr) for further information.

How to apply? Please send a CV and a cover letter to Filipa Lopes using the above-mentioned contact information.

References:

**References from the LGPM team*

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Figure 1 – Astaxanthin production (in red) in open-ponds (Figure on the left). Closed photobioreactor (Figure on the middle). Rotating biofilm-based systems at pilot and lab-scales (Figures on the right), (Bernstein et al., 2014, Morgado et al., 2023)