



Training in microalgae-related industrial processes

Academic coordinator: F. Gabriel Ación/Tomás Lafarga Poyo

Hours: 40 h

<https://www.ual.es/estudios/study-abroad/cursos-de-verano/2024/microalgae-industrial-processes>

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INTRODUCTION

This is an intensive course about microalgae-based processes, on which expertise from academia and industry explain the major aspects of these processes. The course will cover all the aspects related to microalgae-based processes, from (i) the modelling of strains and light utilization, to (ii) the design and operation of photobioreactors, (iii) harvesting and processing of the biomass to achieve reliable and high-value products, and (iv) scale-up to commercial size. Fundamental and practical aspects will be covered always including the participation of internationally recognised researchers, and young researchers and the exchange of experiences between the assistants. Lecturers have extensive experience in bioeconomy, climate change, and the development of processes that will make industrial production more sustainable in the future.

The course is oriented towards PhD students or equivalent experience students in microalgae biotechnology and chemical engineering fields from whatever fundamental area as microbiology, biology or biological/ biochemical engineering, chemistry and biochemistry.

The course is also intended to allow those working in the industry to upgrade their knowledge in microalgae biotechnology.

MAIN GOALS

1. To provide the basic knowledge, and needed skills to grow microalgae, characterize the biomass and conceptualize microalgae processes.
2. To demonstrate the feasibility of microalgae-related processes and identify the markets in which these processes can be suitable
3. To provide access to real data and experience of microalgae-related industrial processes

CONTENT

Module	Description
MODULE 1: Biology and basic principles of microalgae cultures	The microalgae cell. Photosynthesis and kinetic models. Basic techniques of microalgae culture and maintenance. Stoichiometry and kinetic of microalgae cultures. Microalgal culture optimization outdoors. In this module, the fundamentals of microalgae production are reviewed. Major factors influencing the growth of microalgae in addition to modelling of this behaviour are included. The module is completed with laboratory practices on light irradiance measurements, Chlorophyll fluorescence quenching measurements, photosynthesis rate and photosynthetic efficiency.
MODULE 2: Fundamentals of microalgae photobioreactors	Fundamentals of PBR design. Fluid-dynamics and mass transfer in PBR. Heat and momentum transfer in PBR. In this module, the fundamentals of the design of photobioreactors for the production of microalgae are reviewed. This includes mass and heat transfer phenomena and how mixing influences the light regime to which the cells are exposed in the culture. The module is completed with experiments in pilot-scale photobioreactors located at the IFAPA



	research centre as part of the research platform SABANA. Measurement of culture conditions gradients in raceway and thin-layer reactors, and variation of those culture conditions when modifying mass transfer (air/CO ₂) into the reactor.
MODULE 3: Control of microalgae related processes	Control of microalgae-related processes. Basic and advanced control strategies. Influence of control systems on the performance of the processes. In this model, the development of control strategies adapted for microalgae-related processes will be reviewed, moreover, the influence of these strategies on the performance of the overall processes will be analyzed.
MODULE 4: Harvesting and processing of microalgae biomass	Microalgae harvesting (coagulation-flocculation, sedimentation, filtration and centrifugal recovery). Cell disruption. Fundamentals of recovery, extraction, isolation and purification of microalgae products. Microalgae biorefinery concept. In this module, the processes required for the harvesting and processing of microalgae biomass are reviewed. The challenge is to minimize the energy and cost of these operations at the same time that maximizing the quality of end-products. The module is completed with laboratory practices on harvesting (coagulation-flocculation-sedimentation), cell disruption and extraction methods. Major aspects to be studied will involve flocculation and centrifugation experiments.
MODULE 5: Economic and sustainability analysis of microalgae processes	Life cycle analysis. Risk analysis. Techno-economic analysis. In this module, the sustainability of microalgae-related processes is reviewed. Both environmental and economic aspects will be studied, in addition, also social sustainability will be introduced. The module is completed with the visit and revision of the SABANA project such as the case study.
MODULE 6: Commercial applications of microalgae	Food ingredients from microalgae (tailored lipids, carotenoids and PUFAs). Phycobiliproteins recovery and purification. Commodities and bulk chemicals (biofuel and biofertilizer). Microalgae and Aquaculture. Wastewater treatment with microalgae cultures. In this module, a general overview of the most relevant applications of microalgae is performed. Successful commercial processes in addition to potential new processes will be included. The module is completed with the revision of the BIORIZON project such as the case study.

COURSE METHODOLOGY

In-lab sessions <input checked="" type="checkbox"/>	Company visits <input checked="" type="checkbox"/>
Academic visits <input type="checkbox"/>	Talks <input type="checkbox"/>
Lectures <input checked="" type="checkbox"/>	Others <input type="checkbox"/>

Each module will be divided into three hours of lectures and two hours of practice plus two hours of simulations and work with the computer. Course lectures (15 h), short lab and pilot plant practical (14 h) and simulation/computer work (9 h). The language of the course is English. On the course will participate experts from academia and private companies all of them with extensive experience in the field.


ACADEMIC VISITS & NETWORKING

- **SABANA demo facility at IFAPA research centre: to perform practices and training**
- **BIORIZON BIOTECH: Industrial facility producing biostimulants and biopesticides**
- **FCC AQUALIA: Industrial facility performing wastewater treatment**
- **Simulation of microalgae processes using virtual simulators**
- **Techno-economic analysis of microalgae-related processes**

DATE	TIME	CLASS/ACTIVITY	LOCATION ⁱ	PROFESSOR
MODULE 1				
July, 1 st	9:00-12:00	Biology and basic principles of microalgae cultures	IFAPA research center	Jose María Fernández Sevilla (UAL)
July, 1 st	12:00-14:00	Training in biology and basic principles of microalgae cultures	IFAPA research center	Cintia Gómez Serrano (UAL)
July, 1 st	16:00-19:00	Simulation of biological processes	UAL/On-line	Enrique Rodriguez Miranda (UAL)
MODULE 2:				
July, 2 nd	9:00-12:00	Fundamentals of microalgae photobioreactors	IFAPA research center	Gabriel Acien (UAL)
July, 2 nd	12:00-14:00	Training in fundamentals of microalgae photobioreactors	IFAPA research center	Rebecca Nordio (UAL)
July, 2 nd	16:00-19:00	Simulation of Photobioreactor	UAL/On-line	Gabriel Acien (UAL)
MODULE 3:				
July, 3 rd	9:00-12:00	Introduction to control of microalgae processes	IFAPA research center	Jose Luis Guzman (UAL)
July, 3 rd	12:00-14:00	Evaluation of control strategies in microalgae photobioreactors	IFAPA research center	Enrique Rodriguez Miranda (UAL)
July, 3 rd	16:00-19:00	Simulation of control strategies	UAL/On-line	Enrique Rodriguez Miranda (UAL)
MODULE 4:				
July, 4 th	9:00-12:00	Harvesting and processing of microalgae biomass	IFAPA research center	Tomás Lafarga (UAL)
July, 4 th	12:00-14:00	Training in harvesting and processing of microalgae biomass	IFAPA research center	Martina Ciardi (UAL)
MODULE 5:				
July, 4 th	16:00-17:00	Techno-economic analysis of microalgae processes	UAL/On-line	Gabriel Acien (UAL)
July, 4 th	17:00-19:00	Sustainability of microalgae processes	UAL/On-line	Paula Pérez-López (PSL)
MODULE 6:				
July, 5 th	9:00-10:30	Visit to commercial facilities at Biorizon Biotech	Biorizon Biotech facility	Silvia Villaró (UAL)
July, 5 th	10:30-12:00	Visit to commercial facilities at AQUALIA	Aqualia facility	Silvia Villaró (UAL)
July, 5 th	12:00-14:00	Commercial application of microalgae	UAL/Online	Luisa Gouveia (LNEG)
July, 5 th	16:00-19:00	Q&A Conclusions	UAL/Online	Gabriel Acien (UAL)

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