UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biotechnological Processes and Biorefineries

2021-3-E0201Q079

Aims

Microbial processes constitutes one of the key elements in the occurring turnabout from linear to circular economy, and more precisely they are of pivotal importance in all the aspects of Circular Bioeconomy. This is mainly due to the increasing knowledge and awareness of the role of microorganisms on our living planet: they are responsible of the dynamic balance between organic and inorganic state of the chemical elements essential for life, and the products of one microbial transformation become the potential substrates for other processes. This principle, together with the awareness that the overshoot day (that is the day in which an entire year's worth of natural resources is consumed) is anticipating every year since 1972, converges in the willing to develop microbial processes that can be viable, economically competitive and sustainable. The course aims to provide students with the basic knowledge necessary to understand the key elements of a microbial process, giving them the possibility to develop a critical and personal view fundamental for being actor of the occurring industrial transition.

Knowledge and understanding
The student will gain knowledge and the principles of bio-based processes, biorefinery, different generations, key steps of a bioprocess together with prs and cons and criticisms

Applying knowledge and understanding
The student will be able to apply the acquired knowledge to evaluate when and how to develop a bioprocess.

Making judgements
The student will be able to process the acquired knowledge towards the application of bioprocesses in industrially relevant conditions.

Communication skills
Use of an appropriate scientific/chemical vocabulary and ability in oral reports

Learning skills
Skills in literature reading and understanding, skills in the elaboration of interconnections among the course-related knowledge and other subjects related to industrial bio-based microbial processes and biorefineries.

Contents

The course shed lights on the basic knowledge necessary to understand the different fields of application of Industrial biotechnology. This implies to deeper investigate concepts as bioprospecting but at the same time to increase the competence in the knowledge of the infrastructures of an industrial (bio)process, from upstream to downstream, including the description of industrial media and substrates. In this logic, one of the key enabling technology of this groundbreaking field is the biorefinery, where residual biomasses not interfering with the food supply chain are valorized into a diverse array of products. This concept will be presented and several examples of ancient and modern processes related (directly or indirectly) to this approach will be examined. The students will learn which are the feedstoks used in industrial bioprocesses as well as which are the steps of the downstream processes and starting from that we will go through a series of bioprocesses that are more complex and technologically advanced, and more and more pose ethical issues as well as offer solutions to the increasing demands for goods and services.
The following topics will be addressed:

1. Biotechnological processes.
2. The concept of Biorefinery.
3. Feedstocks and substrates.
4. Downstream processes.
5. Production of microbial biomass.
6. Production of biofuels.
7. Food and beverages.
8. Production of secondary metabolites.
9. Production of chemical platforms.
10. Enzymes and microbial conversions.
11. Waste water treatment and biogas production.
12. Screening.
13. Life cycle assessment.

Detailed program

1. Biotechnological processes. Brief historical overview on the concepts of biotechnology, and how they apply to ancient and modern productions. Overview of the different stages of a bioprocess.
2. The concept of Biorefinery. Depiction of principles, implications, technologies and connection with the territory. The different generations of biorefineries will be also presented.
3. Feedstocks and substrates. Which are the substrates mainly used in industrial bioprocesses? Which can be considered for the future? Pros, cons and economical evaluation.
4. Downstream processes. Principles for separation and purification of the products of interest, starting from the moment in which the upstream process is over. Instruments and techniques
5. Production of microbial biomass. Bakers' yeast. Single cell proteins. Depiction of the processes of production, from the preparation of the media to the formulation of the selling product
6. Production of biofuels. Explanation of the different classes (ethanol, butanol, biodiesel, etc) and generations (first, second, third) of biofuels that can be produced by microbial fermentation and depiction of running processes.
7. Food and beverages. Importance of microbial fermentations in the field, and examples of fundamental processes. Case study: beer production.
8. Production of secondary metabolites. Case study: antibiotics.
9. Production of chemical platforms.
10. Enzymes and microbial conversions. How enzymes can be produced and how their development is pivotal for many different industrial bioprocesses, as for semisynthetic antibiotics

11. Waste water treatment and biogas production. Explanation of principles, techniques and possible filed for improvement
12. Screening. General principles and case studies that can exemplify the potential of screening protocols to unveil biodiversity
13. Life cycle assessment. Principles and examples

Prerequisites

Background: basic knowledge in general, organic and biochemistry, and microbiology.
Specific prerequisites: Industrial Microbiology.
General prerequisites: Students can take the exams of the third year after having passed all the exams of the first year of the course.

Teaching form

Because of the Covid-19 restriction, lessons will be provided online, mainly as syncro, following the timetable, but whenever needed also with registered contributions, as also defined together with participants during the first lesson.

Classroom lectures supported by PowerPoint presentations. During the lessons, students will have the opportunity to test their understanding through different types of exercises (multiple-choice tests and exercises with the teacher's guide).

Teaching language: italian.

Textbook and teaching resource

Learning material (slides of the lessons, suggested websites and recommended publications) is available at the e-learning web page of the course.

Recommended textbooks:
- Biotecnologie Microbiche (Donadio, Marino Casa Editrice AMBROSIANA)
- Microbiologia Industriale (Manzoni, Casa Editrice AMBROSIANA)
- Industrial Microbiology: An Introduction (Waites, Morgan, Rockey, Higton, Blackwell Science)
- Biorefineries: Industrial Processes and Products (Kamm, Gruber, Kamm Casa Editrice: Wiley-VCH)
- Encyclopedia of Bioprocess Technology (Flickinger, Drew Casa Editrice: Wiley Interscience)
- Brock – Biologia dei Microrganismi (Madigan, Martinko, Stahl, Clark – Casa Editrice PEARSON)

Semester

First semester

Assessment method

The assessment of the knowledge learned will be carried out by an oral exam at the end of the course. During the exam, the student will have to present one scientific article, among a number that are suggested for each year course, to answer to one open question to articulate giving a complete picture of the requested subject, from general to specific aspects. Finally, few specific questions will be also asked.

Office hours

Contact: on demand, upon request by mail to lecturer or during the lecture.