



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Fermentations and Microbial Bioprocesses

2324-3-E0201Q060

Aims

Learning objectives

From the point of view of **learning**, the objectives are:

- Learning of the different process techniques and technologies in the field of fermentation processes, giving ample emphasis to the conditions necessary for the development of a process that can be carried out on an industrial scale.
- Learning the methods of quantitative analysis of a fermentation process
- Learning of the process design methods that must correlate the physiological and metabolic characteristics of microorganisms and the requirements of an industrial fermentation process.

Application of acquired knowledge

- The student will be able to characterize a fermentation process from a quantitative point of view and will be able to define what are the necessary data that allow an appropriate and complete evaluation of a process
- The student will be able to sketch the design of a fermentation process based on the physiological and metabolic characteristics of microorganisms and on the requirements of an industrial fermentation process.
- The student will be able to analyze, apply and integrate the knowledge acquired with what will be learned in courses related to the production of products of the biotechnology industry.

Contents

The course will focus on the following topics:

- Fundamental requirements for the implementation of an industrial scale fermentation process
- Crucial elements for planning a production process

- Practical bioreactor technology and schemes of bioreactors for biological processes
- Elements and methods of control of bioreactors
- Kinetics of microbial growth and production
- Different fermentation modes (e.g., Batch, Continuous cultures and Fed-Batch)
- Quantitative analysis of processes: productivity, yields and mass balances
- Case Studies: examples of industrial fermentation processes (including problem solving cases)

Detailed program

- Fundamental requirements for the implementation of an industrial-scale fermentation process
Production media, fermentation methods, waste treatment, process productivity
- Crucial elements for planning a production process
Definition of the "dead times" of a production process and their consideration in the process planning phase
- Elements of bioreactoristics and schemes of bioreactors for biological processes
Types of bioreactor: bubble column, air lift, stirred tank.
Focus on stirred tanks: different types of stirrers; oxygen transfer rate (OTR);
- Elements and methods of control of bioreactors
Definition of measured, determined and calculated parameters
Probes for process monitoring
Methods and modes of process control
- Kinetics of growth and microbial production
Definition and quantitative analysis of lag phase, exponential phase and stationary phase
Specific growth rate
Monod's law and relationship with the fermentation process
- Different fermentation modes (e.g, Batch, Continuous cultures and Fed-Batch)
Definition of the different fermentation modes
Analysis of the differences between the different fermentation modes
Application of the different fermentation modes
- Quantitative analysis of processes: productivity, yields and mass balances
The different types of processes (batch, continuous culture, fed-batch) are quantitatively characterized by:
 - Calculation of productivity
 - Calculation of yields
 - Mass balances (including degree of reduction balance)
- Case Studies: examples of industrial fermentation processes (including * problem solving * cases)
Some case studies highlighting the correlation between the physiological / metabolic features of a microorganism and the process characteristics will be presented (e.g. production of citric acid, production of lysine)

Prerequisites

- Background: Basics of biochemistry and Industrial 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

Teaching activities will be in the form of frontal lectures.

In addition to "classic" lectures, there will also be sessions in which the principles of the theoretical lessons are applied to the resolution of exercises.

Students will be able to solve the exercises in groups or individually with the "active" presence of the teacher.

The course is held in Italian and the support material for the lessons (slides and reference and in-depth material) will be mainly in English.

In non-emergency periods the lessons are video-recorded (asynchronous).

During the Covid-19 emergency period, lessons will take place in a mixed mode: partial attendance and asynchronous / synchronous videotaped lessons.

Textbook and teaching resource

Learning material will be available at the e-learning web page of the course.

A few of the reference books that are used for lectures are:

1. Biochemical Engineering

A Textbook for Engineers, Chemists and Biologists

Second, Completely Revised and Enlarged Edition

2015 Wiley-VCH Verlag GmbH & Co.

KGaA, Boschstr. 12, 69469 Weinheim, Germany

Print ISBN: 978-3-527-33804-7; ePDF ISBN: 978-3-527-68499-1; ePub ISBN: 978-3-527-68501-1

2. Bioreaction Engineering

Principles

John Villadsen, Jens Nielsen, Gunnar Lidén

Third Edition

Springer New York Dordrecht Heidelberg London

ISBN 978-1-4419-9687-9 e-ISBN 978-1-4419-9688-6

DOI 10.1007/978-1-4419-9688-6

3. Practical fermentation Technology

Edited by Brian McNeil and Linda M. Harvey

2008 John Wiley & Sons, Ltd.

ISBN: 978-0-470-01434-9

Semester

Second semester

Assessment method

Written test + optional oral test.

Typically two exercises and two open questions are proposed within the written test. The student is requested to solve practical problems related to the analysis of fermentation processes, applying calculations and principles learned during the course. Open questions are on specific parts of the course program and touch general aspects of fermentation technologies and case studies presented during the course.

Office hours

On demand

Sustainable Development Goals

AFFORDABLE AND CLEAN ENERGY | INDUSTRY, INNOVATION AND INFRASTRUCTURE | RESPONSIBLE
CONSUMPTION AND PRODUCTION | CLIMATE ACTION
