

Course Unit	Bioprocess Engineering	Field of study	Biotechnology
Master in	Chemical Engineering	School	School of Technology and Management
Academic Year	2025/2026	Year of study	2
Type	Semestral	Semester	1
Level	2-2	ECTS credits	6.0
Code	6362-756-2102-00-25		
Workload (hours)	162	Contact hours	T 30 TP - PL 30 TC - S - E - OT - O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Ricardo Frederico Pereira Dias

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Know the different cell growth kinetics and enzyme kinetics.
2. Design homogeneous and heterogeneous bio-reactors.
3. Distinguish the different steps from a typical separation process in biotechnology and the unit operations typically used in each step.

Prerequisites

Before the course unit the learner is expected to be able to:
know the fundamentals of reaction engineering, separation processes and transfer phenomena.

Course contents

Enzymes; Cell growth; Bioreactors; Bioseparations.

Course contents (extended version)

1. Enzymes
 - Mechanisms of enzyme kinetics, deactivation and inhibition.
 - Effects of physicochemical properties of the media on the enzymatic activity.
 - Enzyme immobilization methods such as cross-linking, microencapsulation and occlusion.
 - Effects of enzyme immobilization on the reaction rate.
2. Cell growth
 - Yields in cell growth: overall and instant yields; theoretical and observed yields.
 - Substrate consumption with and without product formation.
 - Different product formation kinetics and their relationship with energy metabolism.
3. Bioreactors
 - Biological reactors such as chemostat, batch reactor, fed-batch and air-lift.
4. Bioseparations
 - Main steps in a classical bioseparation process departing from a given fermentation broth.
 - Filtration in the presence of compressible and incompressible filter cakes.
 - Effect of the shape of the cells on the performance of filtrations.
 - Filtration with centrifugation.
 - Liquid-liquid extraction using aqueous biphasic systems.
 - Electrodialysis.
 - Isoelectric focusing.
 - Cell disruption processes.

Recommended reading

1. P. A. Belter, E. L. Cussler, W. Hu, Bioseparations – Downstream Processing for Biotechnology, John Wiley & Sons, 1988.
2. P. M Doran, Bioprocess Engineering Principles, 2nd edition, CRC Press, 2013.

Teaching and learning methods

Bioprocess design concepts and techniques will be covered in theoretical classes, with resolution of application exercises in theoretical-practical classes. The following topics will be covered in laboratory classes: yeast filtration, hydrodynamics in bioreactors, enzyme kinetics, mass transfer in cell cultures and analysis methods.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary, Special)
 - Final Written Exam - 50%
 - Reports and Guides - 40% (Five reports about the laboratory work.)
 - Development Topics - 10% (Seminar on a bioprocess presented by students in the penultimate week of classes.)
2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
 - Final Written Exam - 100% (Final global exam.)

Language of instruction

English

Electronic validation

Ricardo Frederico Pereira Dias	Maria Filomena Filipe Barreiro	Simão Pedro de Almeida Pinho	José Carlos Rufino Amaro
30-09-2025	06-10-2025	10-10-2025	01-11-2025