

Course Unit	Bioprocess Engineering		Field of study	Biotechnology	
Master in	Chemical Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	2	Level	2-2
Type	Semestral	Semester	1	Code	6362-756-2102-00-23
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) Maria Olga de Amorim Sá Ferreira, Pedro Jorge Louro Crugeira

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

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04-10-2023	25-10-2023	25-10-2023	31-10-2023