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	ECTS credits	6.0
Type	Semestral	Semester	1	Code	6362-756-2102-00-23

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

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

Maria Olga de Amorim Sá Ferreira	Hélder Teixeira Gomes	Simão Pedro de Almeida Pinho	José Carlos Rufino Amaro
04-10-2023	25-10-2023	25-10-2023	31-10-2023