27124 - Bioreactors

Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	446 - Degree in Biotechnology
ECTS	6.0
Course	4
Period	First semester
Subject Type	Compulsory
Module	---

1.Basic info

1.1.Recommendations to take this course

The professors teaching this subject belongs to the areas of Chemical Engineering and Biochemistry and Molecular Biology.
To take this course is recommended to have passed the subjects of Mathematics, Chemistry, Physics and Chemical Engineering.

1.2.Activities and key dates for the course

The subject is taught in the first semester. Teaching activities are developed in theory classes, solving numerical problems and laboratory practices.
Tests will be conducted during the official period marked by the Faculty of Science.
For those enrolled students, the times and dates of lectures and practical sessions will be announced through the official notice board Biotechnology Grade, and also in the moodle platform. These media will also be used to communicate to students enrolled, their distribution by groups of practices, made from the coordination of the Degree.
A tentative dates will be available on the website of the Faculty of Science in the relevant section of the Degree in Biotechnology: https://ciencias.unizar.es/grado-en-biotecnologia.
In this web may also consult the exam dates.

2.Initiation

2.1.Learning outcomes that define the subject

Know the different types of bioreactors and their main operating characteristics.
Know the main kinetic models applicable to enzymatic and microbial processes.
Understand and apply the different methods of estimating the kinetic parameters.
Understand and apply the equations for the basic design of enzymatic and microbial bioreactors.
Know the basic methods of selection and optimization of ideal reactors.
Know and select different methods of immobilization of biocatalysts.

2.2.Introduction

This course has as main objective the acquisition by students of the Degree of Biotechnology, of the theoretical and practical knowledge of the discipline of engineering biochemical reactions. The skills acquired in this field have to serve

graduates in their later professional practice, which should address biotechnology projects in multidisciplinary environments.
The basic aspects of the subject will be the domain of theory and the correct resolution of problems related to: I) Enzyme and microbial kinetics; II) Design and optimization of fundamental types of enzyme and microbial bioreactors; and III) Methods of immobilization of biocatalysts.

3.Context and competences

3.1.Goals

1. Know and use the concepts and nomenclature and basic concepts of biochemical reactions Engineering
2. Propose, develop and solve kinetic models for enzymatic and microbial processes.
3. To know the mechanisms of immobilization of biocatalysts, and mass transfer phenomena in reactors with immobilized biocatalysts.
4. Know and apply the basic equations of design and optimization of biochemical reactors.
5. Know the main criteria for selection of bioreactors.

3.2.Context and meaning of the subject in the degree

The industrial development of bioprocesses requires knowledge by the biotechnologist of performance and main characteristics of different types of enzyme and microbial bioreactors.
From the kinetic models involved in these processes, in this subject are provided the necessary tools to attain knowledge of the basic methods of selection, design and optimization of equipment where this kind of reaction pass.

3.3.Competences

Calculate the numerical values of the parameters shown in the different enzymatic and microbial kinetic models.
Apply and select different methods of immobilization of biocatalysts
Select and design enzymatic and microbial bioreactors: batch, fed-batch and continuous.
Optimize the enzymatic and microbial bioreactors operation.

3.4.Importance of learning outcomes

Learning outcomes described above are necessary to conceive, design, optimize and operate the various basic types of industrial bioreactors.

4.Evaluation

Class participation will account for 15% of the final grade and will be the sum of the contributions that students make in class throughout the course. This section contains the active participation in the classes of theory and practical problems, delivery problems solved and the development and delivery of laboratory practice report after the completion of these it will be included. Laboratory practices are mandatory for all students enrolled.
Performing a written final exam, including a part of theory and other problems. This test will account for 85% of the final grade.
The evaluation of the problems will be assessed both the correct application of the calculation procedures, such as obtaining a correct numeric result.
In addition to the evaluation modality indicated in the above points, the student will be able to be evaluated in a comprehensive examination (written test), which will assess the achievement of learning outcomes outlined above. This may include a written examination on the content of laboratory practice, in case they would not have done test.
The topics that students can use to prepare the different tests is in the "Program" section of this same teaching guide.

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5.Activities and resources

5.1.General methodological presentation

In the lectures, the theoretical concepts of the subject will be presented and accompanied by explanatory examples. In addition, they will arise and solve problems and case studies directly related to the theoretical concepts that will expose along the course.
Exercises to solve at home, the resolution will be discussed in the class is proposed. Classes, both theory and practical problems, will be participatory, and there will be tutorials to address the doubts of students.
The laboratory practice sessions are complementary to the lectures and numerical problems. They are done in groups of 2 students, in a participatory and collaborative way. After laboratory work, students prepare a report where a discussion of the experimental methodology used and the results obtained and their meanings are included.

5.2.Learning activities

Sessions exposure of the theoretical contents, which are presented in a participatory manner with students, the basic concepts included in the course syllabus.
Classes dedicated to solving problems, in which the participation of students will be promoted more intensely so than those dedicated to the exhibition of the theoretical contents.

Solving numerical problems and methodological developments in which, with the participation of students, proposed exercises will be solved by both the teacher and pupils. These classes will be taught in full coordination with the lectures. Laboratory practices. The plan of work assigned to this part a total of 0.5 ECTS. In this part of learning and practices for managing different experimental techniques immobilization of biocatalysts they were made.

In addition, visits to industrial facilities that develop biotechnological processes were made.

5.3.Program

BIORREACTORS

Chapter 1. Introduction to biochemical reaction engineering. Biochemical products and processes.

Chapter 2. Kinetics of enzyme catalysed reactions. Reactions with one substrate: General model and Michaelis-Menten and Briggs-Haldane approximations. Methods of calculation of kinetic parameters. Reversible reactions. Reactions with several substrates. Cooperativity: Hill model. Types and kinetic effects of inhibition. Influence of pH and temperature. Enzyme deactivation.

Chapter 3. Immobilization of enzymes and biocatalysts. Technology of enzymatic immobilization. Types of immobilization: adsorption, covalent bond, cross bonds, self-immobilization, membranes. Selection of the immobilization method. Effects of immobilization on the mass transfer resistances. External and internal effectiveness factors.

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Chapter 4. Design of enzymatic bioreactors. Ideal bioreactors: Batch reactor, fed-batch reactor, continuous stirred tank reactor (CSTR), CSTR in series, plug-flow reactor. Productivity and optimization of ideal reactors. Effect of enzyme inhibition and deactivation. Comparison of bioreactors.

Chapter 5. Microbial growth kinetics. Stoichiometry, yield and reaction rate. Kinetics of substrate consumption and product formation. Phases of cellular growth. Non-structured models. Substrate limited growth: Monod model. Other kinetic models. Effects of inhibition. Diauxic growth. Environmental effects. Thermal death kinetics. Introduction to structured kinetic models.

Chapter 6. Design of microbial fermenters. Types of reactors: Batch and Fed-batch reactors. Continuous stirred tank: Chemostat. Chemostat with recycle. Chemostats in series. Plug flow fermenter. Multiphase fermenters. Comparison and selection of bioreactors.

5.4.Planning and scheduling

The period of the lectures and problems coincide with the schedule of classes officially established. This is available at the following link: https://ciencias.unizar.es/grado-en-biotecnologia.
The timetable and laboratory practice groups will be established in coordination with the other subjects, at the beginning of the academic year. At the beginning of the course, the coordinator of the degree distribute practice groups in order to avoid overlaps with other subjects.

5.5.Bibliography and recomended resources

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- Dutta, Rajiv. Fundamentals of biochemical engineering / Rajiv Dutta Berlin : Springer ; New Delhi : Ane Books India, cop. 2008
- McDuffie, Norton G.. Bioreactor design fundamentals / Norton G. McDuffie Boston [etc.] : Butterworth-Heinemann, cop. 1991
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