Universidad Zaragoza

Year : 2019/20

27124 - Bioreactors

Syllabus Information

Academic Year: 2019/20
Subject: 27124 - Bioreactors
Faculty / School: 100 -

Degree: 446 - Degree in Biotechnology

ECTS: 6.0
Year: 4
Semester: First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

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.

1.2.Context and importance of this course 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.

1.3.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.

2.Learning goals

2.1.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.

2.2.Learning goals

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.

2.3.Importance of learning goals

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

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

Option 1:
The evaluation is global and includes:
Realization of laboratory practices. The attendance, the presentation of a brief report of the activity, as well as the presentation and interpretation of the obtained results will be evaluated.
Realization of student's autonomous works. The deliverables corresponding to these works will be graded considering their contents, the understanding of the concepts that ared and the correct presentation.

Realization of a final exam. This test will consist of: (a) qtheoretical-practical questions reasoned in which the application of the theory will be asked to specific cases and examples, and (b) problem solving.

The grade of the subject will be calculated according to the following formula: Note = 0,1 P + 0,1 T + 0,8 E
Being: P the mark of the laboratory practices (evaluation activity 1), T the note of the supervised works (evaluation activity 2), and E the final examination note (evaluation activity 3).
 A minimum grade is required on the exam, E, of 4.0 out of 10 to pass the subject.

Option 2:
Those students who do not want to follow the evaluation according to option 1, can choose to take the exam (100% of the final mark) with similar characteristics as the final exam of option 1 (evaluation activity 3).

Additional comment: The total or partial fraud or plagiarism in any of the evaluation tests will lead to the suspension of the subject with the minimum mark, in addition to the disciplinary sanctions that the guarantee commission adopts for these cases.

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. It is based on lectures, class of problems and that favors the development/acquisition of the main topics of the subject. A wide range of teaching and learning tasks are implemented, such as solving problem classes, use of spreadsheets, and critical revision of scientific papers related to the topics.

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.

Students are expected to actively participate in the class throughout the semester.

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, the results obtained, and their meanings are included.

Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other learning resources such as several web links provided in the classroom notes. Further information regarding the course will be provided on the first day of class.

4.2.Learning tasks

The course includes the following learning tasks:

- Lectures (36 h). The theoretical contents of the topics will be taught, developing generic cases related with the main topics of the subject.
- Solving problem cases (19 h). In these classes, the student will solve problems supervised by the teacher. The problems or cases will be related to the theoretical part explained in the lectures.
- Laboratory session (5 h). There will be 1 session of 5 hours. In it the student will study in the laboratory some of the contents developed in the lectures and problem solving classes.
- Works supervised (16 h). During the development of the course, and related to the main topics, the students will be proposed to carry out several works of application and extension of the concepts studied. These will consist of the resolution by spreadsheet, and in an individualized way, of different problems related to the theoretical contents of the subject. The student, together with the spreadsheet, must send an explanatory report of the methods and calculations made for the resolution of each problem. Both documents will be evaluated.
- Autonomous work and study (70 h). The student is advised to carry out the individual study on a continuous basis throughout the term.
- Assessment tasks (4 h). In addition to the evaluation of the reports of the practical session and of the supervised works, there will be a final exam, or an overall test. The theoretical and practical knowledge reached by the student will be evaluated.

4.3.Syllabus

The course will address the following topics:

- Topic 1. Introduction to biochemical reaction engineering. Biochemical products and processes.
- Topic 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.
- Topic 3. 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.
- Topic 4. 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.
- Topic 5. 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.
- Topic 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.

4.4.Course planning and calendar

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.

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.

4.5.Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=27124&year=2019