Universitat Autònoma de Barcelona

2020/2021

# Bioreactors

Code: 100961
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2500253 Biotechnology | OB | 2 | 2 |

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

## Contact

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## Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

## Prerequisites

To follow up this subject it is relevant to have completed previously the following topics: Mathematics, Biochemistry, Numerical Methods and Computation and Fundamentals of Bioprocess Engineering

## Objectives and Contextualisation

Bioreactors are an essential element in any biotechnological process in wiche the potentialities of a biocatalist (enzymes, cells, viruses) is exploited to obtain a product or a service. In such a context it is basic to design, buid and operate the required bioreactors for each specific application, that is dictated by the characteristics of the biocatalist (for example the reaction and cell growth kinetics) and its needs (operational conditions, culture media, oxigen supply, mixing, etc.).

The objectives of the topic are:

- To know about the main bioreactor types, their basic cjaracteristics and main applications, both for processes using enzymes and microorganisms

- To study the necessary elements to perform a bioreactor design, such as the most common kinetic equations and design equations

- To perform the analysis of ideal bioreactors and, on that basis, determine the requierements of real bioreactors.

- To analyse the most relevant factors in the oprration of a real bioreactor (mixing, esterilization, aeration), the tools for residence time distribution analysis and scale-up.

## Competences

- Describe the principles behind the design and functioning of bioreactors and calculate, interpret and rationalise the main parameters in transport phenomena and the matter and energy balances in bioindustrial processes.
- Lead and manage teams, and develop capacities for organisation and planning

- Read specialised texts both in English and ones own language.
- Reason in a critical manner
- Search for and manage information from various sources.
- Think in an integrated manner and approach problems from different perspectives.
- Use ICT for communication, information searching, data processing and calculations.
- Use the fundamental principles of mathematics, physics and chemistry to understand, develop and evaluate a biotechnological process.

## Learning Outcomes

1. Correctly use a bioreactor.
2. Lead and manage teams, and develop capacities for organisation and planning
3. Propose a design for a bioreactor that fits its application.
4. Read specialised texts both in English and ones own language.
5. Reason in a critical manner
6. Search for and manage information from various sources.
7. Solve problems in different key aspects of bioindustrial processes.
8. Think in an integrated manner and approach problems from different perspectives.
9. Use ICT for communication, information searching, data processing and calculations.

## Content

The topic consists of the following blocks:

1. Introduction: Bioprocess engineering. Aspects influencing the design of a bioreactor. Ideal and real reactors. Main tyoes of bioreactors. Basic design equations for idel reactors.
2. Enzymatic kinetics: Kinetics of reactions with a single substrate. Determination of kinetic parameters. Reactions with inhibition and multiple substrates. Variation of enzymatic activity with temperature and pH.
3. Microbial kinetics: Estequiometry and yields. Kinetics of cell growth, substrates consumption and product formation. Type of models.
4. Design of ideal bioreactors: Batch stirred tank bioreactor. Continuous stirred tank bioreactor. Continuous plug-flow bioreactor. Systems with feeding (fed-batch). Systems with recirculation. Series of reactors.
5. Design of real bioreactors: Aeration, mixing and esterilization of bioreactors. Mixing and residence time. Non-ideal flux: analysis and models. Scale-up: concepts and most used criteria.

## Methodology

The topic is based on:

- Theory lectures (material available in Campus Virtual)

- Practical exercises lectures (very relevant to work the exercises in anticipàtion to the lecture)

- Own work by student (important to prepare all lectures in anticipation)

- Seminars

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |

| | | | |
|---|---|---|---|
| Practical exrecises | 16 | 0.64 | 9, 6, 8, 3, 5, 7, 1 |
| Seminars | 3 | 0.12 | 9, 6, 4, 8, 3, 7, 1 |
| Theory Lectures | 32 | 1.28 | 4, 8, 3, 5, 7, 1 |
| Type: Autonomous | | | |
| Student own work | 75 | 3 | 9, 6, 2, 4, 8, 3, 5, 7, 1 |

## Assessment

Evaluation will be based on four different components:

a) Two complet exercices, of higher complexity than those normally performed in the exercercice lectures, one after completion of Theme 3 and one after completion of theme 4. Weight of a 30% of the global mark of the topic.

b) One written examination of practical exercices. Weight of 30% of the global mark of the topic.

b) One written examination of theory. Weight of 40% of the global mark of the topic.

To pass the topic a minimum mark of 5.0 should be achieved. It will be also mandatory to have a minimum mark of 4.0 in the exams of Theory and Practical exercises. The two complete practical exercises will be evaluated only one time. For students having to repeat the Course the marks of these two completed exercises will be saved and used for the evaluation of the next course.

In case of failure inTheory or Practical exercises examans, the student will have the option to perform a second examination.

To participate in the second examination, the studnt must have been evaluated of a minimu number of activities corresponding to two thirds oa the total qualification of the topic. Therefore, the student will receive the qualification of "No avaluable" when the activities evaluated performed have a ponderation over 67% of the total qualification.

Appart from other potential disciplinary penalties, the student will be marked with zero in the case of irregularities such as copy, plagism, allow copying, missleading, etc.

## Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Practical exrecises examination | 30% | 2 | 0.08 | 3, 7, 1 |
| Realization of two complete exercises to deliver | 30% | 20 | 0.8 | 9, 6, 2, 4, 8, 3, 5, 7, 1 |
| Theory Examination | 40% | 2 | 0.08 | 3, 7, 1 |

## Bibliography

- Doran, P.M. "Principios de ingeniería de los bioprocesos", 1998, Editorial Acribia, Zaragoza.

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- Gòdia, F., López, J. "Ingeniería Bioquímica", 1998, Editorial Síntesis, Madrid.

- Van't Riet, Tramper, J. "Basic Bioreactor Design", 1991, Marcel Dekker, New York.

- Blanch, H.W., Clark, D.S. "Biochemical Engineering", 1996, Marcel Dekker, New York.

- Bailey, J.E., Ollis, D.F. "Biochemical Engineering Fundamentals", 2ª Ed., 1986, McGraw Hill Book Company, New York.