Universitat Autònoma de Barcelona

2021/2022

Bioreactors

Code: 101022
ECTS Credits: 3

Degree	Type	Year	Semester
2500502 Microbiology	OB	3	1

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: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Prerequisites

No specific requirements are defined for this course

Objectives and Contextualisation

- Knowledge acquisition about relevant aspects related to bioindustrial processes, such as mass balances, bioreactor design and its proper utilization, depending on its specific application.

- Learning about the main bioreactor types, their basic features and their main applications, for both enzymatic and microorganism based processes.

- To study the required elements to design and operate a bioreactor, such as conventional kinetic equations and deign equations, the interaction between the kinetic law and the operation mode, the mixing and aeration hardware, as well as the instrumentation and basic control elements. To analyze the ideal rector types, and from those to determine the requirements for the utilization of real reactors.

Competences

- Apply microorganisms or their components to the development of products of interest in health, industry and technology.
- Communicate orally and in writing.
- Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
- Work individually or in groups, in multidisciplinary teams and in an international context.

Learning Outcomes

1. Apply the most suitable reactor configuration and operating strategy for each type of industrial application.
2. Communicate orally and in writing.
3. Define the effects of changes of scale on different types of bioreactors and applications.

4. Describe the different types of bioreactors.
5. Know and understand the mechanisms of energy and matter transfer.
6. Know the advantages and limitations of the different strategies for improving production processes
7. Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.
8. Use the necessary agitation type for the needs of a specific application.
9. Work individually or in groups, in multidisciplinary teams and in an international context.

Content

UNIT 1.- BIOCHEMICAL ENGINEERING AND BIOTECHNOLOGY.

- The bioreactors in the biotechnological processes.

- *Biotechnology, basic definitions*
- *Productive process and position of bioreactors*

- Enzymatic and microbial kinetic models

- *Definitions*
- *Microbial growth stoichiometry*
- *Celular growth, substrate consumption and product obtention.*
- *Microbial growth kinetic models*
- *Effects of the physico-chemical parameters on the enzymatic activities and on the microbial growth*

- Mass and energy balances

- *Mass and energy conservation principle.*
- *Mas balances in bioreactors.*

UNIT 2.- IDEAL BIOREACTORS

- Basic bioreactor design

- *Classifying bioreactors*
- *Ideal bioreactors: continuous and batch operation.*
- *Fed-batch operation. Systems with recirculation. A series of reactors.*

UNIT 3.- REAL BIOREACTORS

- Typical configurations and bioreactor elements.

- *Real bioreators: examples*
- *Non ideal flow*
- *Advanced Bioreactors*

UNIT 4.- OPERATION, INSTRUMENTATION AND CONTROL OF BIOREACTORS.

- Aeration

- *Oxygen transfer.*
- *Aeration and its eficiency.*
- *Determination of the $k_L a$ coefficient.*

- Mixing

- *Fermentation browth reology*
- *Shear stress effects.*
- *Mixers.*
- *Mixing and aeration.*

- Bioreactor scale-up

- Control and instrumentation:

  - *Definitions*
  - *Needs and incentives*
  - *Elements of a control system*
  - *Implementation of a control system: pH control, temperature control and dissolved oxygen*

Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

Methodology

LECTURES (20h): lectures will introduce the basic concepts of the course contents. If possible interactive audiovisual material to assist concept understanding.

WORKSHOPS (3h): workshops have as aim to strengthen the theoretical concepts with representative practical cases. Realistic use of bioreactors for production process with be targeted. Discussion and group working will be favored.

The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	20	0.8	6, 5, 3, 4, 7, 8
Workshops	3	0.12	1, 6, 3, 4, 2, 9, 7
Type: Supervised			
Team working	10	0.4	1, 6, 4, 2, 9, 7
Type: Autonomous			
Study	38	1.52	1, 6, 5, 3, 4, 2, 9, 7, 8

Assessment

- GRADES :

Through(i) two individual written tests (defined as Tests 1 and 2 in the calendar) combining development questions with application of acquired concepts to practical cases; (ii) the resoluction of an applied case). For the students either who have not passed the course or did not attend the day of the tests, there will be a last written test (indicated as Recuperation in the calendar) combining development questions with application of acquired concepts to practical cases. Additionally, students who have passed the course willing to improve their grades can also use the retake process. They will do the whole test and the grade will be obtained with the recuperation test (retake process).

To be eligible for the retake process, the student should have been previously evaluated in a set of activities equaling at least two thirds of the final score of the course or module. Thus, the student will be graded as "Not Evaluable" if the weighting of all conducted evaluation activities is less than 67% of the final score

Additional aspects:

- To pass the course it is required a mark of at least 5/10, either through the average of the evaluaction activities or from the recuperation test. To allow average of the evaluations activities (with the ponderation indicated in the table)

- Only failed individual tests require to go through the retake process (hence, individual tests reduce contents of the course).

- A student cannot be evaluated (i.e. marked as "*No avaluable*") when the set of evaluating activities done was lower than two thirds of the total mark of the course.

Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation 1 (units 1 and 2)	45%	2	0.08	6, 5, 4, 2, 9, 7
Evaluation 2 (units 3 and 4)	45%	2	0.08	1, 5, 3, 4, 2, 9, 7, 8
Resoluction of an applied case	10%	0	0	1, 6, 5, 3, 4, 2, 9, 8

Bibliography

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Bailey, J.E., Ollis, D.F. Biochemical Engineering Fundamentals. McGraw Hill. (1986)

Blanch, H.W., Clark, D.S. Biochemical Engineering. Marcel Dekker. (1997)

Gòdia, F., López, J. Ingeniería Bioquímica. Síntesis. Madrid. (1998)

Kosaric, N., Pieper, H.J., Senn, T., Vardar-Sukan, F., "The Biotechnology of Ethanol", Wiley (2001)

Levenspiel, O. "Ingeniería de las reacciones químicas", Wiley (2004)

Ollero de Castro, P.; Fernández Camacho, E. "Control e instrumentación de procesos químicos". Editorial Síntesis. (1997)

Vogel, H.C., Todaro, C.L. "Fermentation And Biochemical Engineering Handbook", Noyes Publications (1997)

Software

During lectures as well as for the proposed tasks the use of EXCEL is widespread.

The optional assignment proposed in the course uses (free) specific software AQUASIM, whose use will be introduced during the course and provided for its use.