ETS Ingeniería Agronómica, Alimentaria y de Biosistemas	
Program	20BT– Degree in Biotechnology

Course number and name	
Number	20504224
Name	Bioreactors
Semester	S1 [(September-January)], 3rd Year

Credits and contact hours	
ECTS Credits	5
Contact hours	60

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Specific course information

Description of course content

The objective of the course is to instruct students in the following topics: Microbial kinetics, mass balances, types of bioreactors, bioreactor design and operation. Microbial growth in bioreactors. Biology of microorganisms of industrial interest. Metabolic pathways of industrial importance and its regulation. Bacterial metabolic engineering. Fundamentals of industrial enzymology. Enzymatic reactors and with immobilized catalysts. Process Scaling.

List of topics to be covered

1. **Introduction:** Bioreactors, biochemical processes and biochemical engineering
2. **Microbial growth in bioreactors**
   2.1. Growth parameters and phases
   2.2. Factors that affect growth: Temperature, pH, oxygen and contaminants
3. **Bioreactor design**
   3.1. System and system limits
   3.2. Modes of operation
   3.3. Material balances
   3.4. Ideal reactors
   3.5. Stirred Tank Reactor Design
   3.6. Non-ideal flow

4. **Bioreactors with aeration and mixing**
   4.1. First fermenters
   4.2. Solubilization of O_2 in aqueous medium
   4.3. The fermenter with aeration and mixing
      4.3.1. The fermentation tank
      4.3.2. Mix control elements
      4.3.3. Temperature control elements
      4.3.4. Process control
      4.3.5. Aeration control elements
      4.3.6. pH control elements, defoamers, axillaries, etc.
      4.3.7. Medium-product separation
5. **Types of bioreactors. Bioreactor operation**
   5.1. Stirred Bioreactor
   5.2. Airlift Bioreactors
   5.3. membrane bioreactors
   5.4. Fixed Bed Bioreactors
   5.5. Photobioreactors
   5.6. Disposable bioreactors
   5.7. Digesters for biogas biosynthesis
6. **Improvement of industrial organisms**
   6.1. Bacterial nutrition and culture media adapted to industrial processes
   6.2. Metabolism of microorganisms of industrial interest
   6.3. Global regulation systems
   6.4. Classic techniques for the improvement of industrial organisms
   6.5. Enhancement through microbial metabolic engineering
7. **Industrial enzymes**
   7.1. Review of enzyme kinetics. Catalytic efficiency
   7.2. Industrial uses of enzymes
   7.3. Enzyme immobilization systems. Enzyme stability
   7.4. Kinetics of immobilized biocatalysts. Electrostatic and steric effects
   7.5. Applications of immobilized catalysts

Prerequisites or co-requisites

- Metabolism and its Regulation
- Microbiology

Course category in the program

Mandatory	

Specific for course objectives

Specific learning outcomes

RA186 –To know and understand the production processes of microbial biomass and its most important uses

RA182 - To know the biotechnological processes carried out by microorganisms and understand their critic aspects
RA185 - Use tools for genetic manipulation of microorganisms to improve biotechnological processes
RA179 – Know and analyse the bases of the design of biotechnological plants
RA183 - Being able to assess the suitability of a microorganism to carry out biotechnological applications

Further reading and supplementary materials

Bibliography

- Bioprocess Engineering (2002). 2ª ed. Prentice Hall. M.L.Shule&F. Kargi
- Principles of Fermentation Technology (1995) 2ª ed. Butterworth Heinemann. P.F. Stanbury, A. Whitaker and S.J. Hall.
- Brock, Biology of microorganisms, (2011) 13ªEd. Pearson Education. M.T. Madigan, J.M. Martinko, D. Stahl and D. P. Clark
- Reactores bioquímicos. (1986) Ed. Reverté. B. Atkinson
- Fermentation a practical approach (1990) Oxford University Press.B. McNeil and L.M. Harvey
- Biotecnología de la fermentación (1991) Editorial Acribia. O.P. Ward
- Process Engineering Principles (2012). Academic Press. P.M. Doran

Supplementary materials

Research Fermenter: Complete fermentation plant for research and breeding of industrial organisms

Laboratory Material : optical microscopes; tools proper of a microbiology laboratory; Incubators; Autoclaves; laminar flow cabinets; Bunsen burners; Spectrophotometers; dissolved oxygen sensors; Centrifuges.

Teaching methodology

_X_ lectures	_ _ problem solving sessions	_X_ collaborative actions	_X_ laboratory sessions
Other:			

Evaluation Criteria

Progressive evaluation. It consists of a partial exam (liberatory) and a final exam, both written, which may include multiple choice questions, essay questions, and problems. The execution of all practice sessions and pass the practice exam (5/10) are required to pass the course.

As a general evaluation criteria for the degree, it is established that of the set of competences linked to this course, activities will be carried out for the evaluation of transversal competences (CT) and specific competences (CE).

It is also intended that the student knows the basic laboratory operations, knows how to handle the material in a microbiological laboratory, and acquire the skill and dexterity

that they will need for subsequent courses, always contemplating adequate security measures.

1- Evaluation of the thematic units developed through classroom activities. These will be evaluated by two exams that may include multiple choice questions, problems and theoretical development questions. The weight of each of these exams represents 45% of the overall grade.
2- Evaluation of the laboratory practices through an individual face-to-face exam. This activity represents 10% of the global qualification. A grade higher than 5 is mandatory to pass the course.

To make the sum of the different evaluable activities carried out by the students, they must obtain a minimum score of 5 out of 10 in each of the partial theoretical and practical exams.