**COURSE: BIOREACTORS**

**SUBJECT MATTER:** Bioreactors  
**MODULE:** Bioprocess Engineering  
**PROGRAM:** Degree in Biotechnology

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**GENERAL FEATURES** *

| Type: | ☐ Basic training, ☑ Compulsory, ☐ Elective  
| ☐ Final Degree Project, ☐ Practicum |
| Duration: | Semestral  
| Semester / s: | 4 |
| Number of ECTS credits: | 5 |
| Language / s: | Spanish, Catalan, English |

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**DESCRIPTION**

**SHORT DESCRIPTION AND JUSTIFICATION** (of the meaning of the course in relation to the studies. Between 100 and 200 words)

This subject aims to cover the basic knowledge of the different kinetics involved in bioprocesses, mainly enzymatic and microbial, as basic knowledge for the design and operation of bioreactors. The bioreactor is an essential part in the bioprocesses from the point of view of manufacturing purpose.

This course has been designed to provide the biotechnologist with the basic knowledge of the different types of bioreactors, the basic tools to decide the most adequate type of bioreactor and the different operating conditions to develop any specific product in a manufacturing scale. To do this, we review the kinetic models that describe the cell growth and the balance of matter and energy needed to design an ideal bioreactor. Finally, concepts that provoke deviations from ideality, such as the limitations of matter and energy transfer are also introduced.

**COMPETENCES** (of the course placed in relation to the pre-assigned competences in the subject matter)

- That students know how to apply their knowledge to their work or vocation in a professional manner, and have acquired the competencies that allow them to elaborate and defend arguments as well as to solve problems within their area of study. (CB2)
- That students develop those learning skills necessary to undertake further studies with a high degree of autonomy. (CB5)
- Be able to assess the impact of their professional activity on the sustainable development of society. (T3)
- Be able to understand and apply advanced knowledge of Biosciences and Engineering to the field of Biotechnology. (E3)
- Be able to use tools, systems or processes to carry out the activities in the field of Biotechnology according to the established requirements. (E4)

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• Be able to integrate the knowledge and tools of biotechnology for their application to different industrial sectors that use, develop or produce biotechnological products or processes. (E6)

PREVIOUS REQUIREMENTS * (modules, subject matters, courses or knowledge necessary for the follow-up of the subject. State previous courses required to be completed)


CONTENTS (List the content of the course, with up to two level detail)

1. Introduction
   1.1. Bioprocess technology
   1.2. Types of bioreactors and applications
   1.3. Balance of matter. Stationary and non-stationary state. General equations for the design of bioreactors (ATCM, RDTA and RFP).

2. Enzymatic kinetics
   2.1. Parameterization of kinetic models
   2.2. Inhibitions
   2.3. Enzymatic deactivation

3. Microbial kinetics
   3.1. Stoichiometry and yields
   3.2. Growth profile
   3.3. Specific speeds of consumption, production and growth
   3.4. Parameterization of kinetic models

4. Design ideal bioreactors
   4.1. Basic operating modes (Batch, Continuous)
   4.2. Complex modes of operation (fed discontinuous, continuous with recirculation, perfusion)
   4.3. Multiple reactors in series

5. Design real bioreactors
   5.1. Agitation
   5.2. Transfer of matter: aeration

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LEARNING ACTIVITIES * (Complete the table relating activities, workload in ECTS credits, and competences.)

<table>
<thead>
<tr>
<th>Learning Activities</th>
<th>ECTS Credits</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>1,1</td>
<td></td>
</tr>
<tr>
<td>Case and Problem-Solving Sessions</td>
<td>0,4</td>
<td></td>
</tr>
<tr>
<td>Seminars</td>
<td>0,1</td>
<td></td>
</tr>
<tr>
<td>Practical and Lab Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Study</td>
<td>3,3</td>
<td></td>
</tr>
<tr>
<td>Assessment Tasks (Exams, Continuous Assessment...)</td>
<td>0,1</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,0</strong></td>
<td><strong>B2, B5, T3, E3, E4, E6</strong></td>
</tr>
</tbody>
</table>

TEACHING METHODOLOGY (justify the teaching methodology in relation to the competences and course contents. Between 100 and 200 words)

- **Lectures** - Presentation and explanation of contents by a teacher (possibly including demonstrations).
- **Case and Problem-Solving Sessions** - Resolution of exercises and problems, and exposition / discussion of cases by a teacher with the active participation of students.
- **Personal study activities** - Personal work of the student necessary to acquire the competences of each subject matter and to assimilate the knowledge exposed in lectures, cases, and problem-solving sessions, using the recommended reference materials. They also include the preparation of tasks related to the other activities, and the preparation of exams.
- **Assessment Tasks** - Oral and / or written tests made during the academic period of a course, or once it has finished (final exams, follow-up controls).

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ASSESSMENT

ASSESSMENT METHODS * (Complete the table relating assessment methods, competences, and weight percentage in the course qualification)

<table>
<thead>
<tr>
<th>Assessment methods</th>
<th>Weight</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Exam</td>
<td>65%</td>
<td>B2, B5, T3, E4, E6</td>
</tr>
<tr>
<td>Midterm Exam/s</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Continuous Assessment Activities</td>
<td>30%</td>
<td>B5, T3, E3</td>
</tr>
<tr>
<td>Reports and Presentations</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lab or Field Work</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Host Student Evaluation</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>5%</td>
<td>B5, T3</td>
</tr>
</tbody>
</table>

LEARNING OUTCOMES (Explanation of the student's achievements that allow the assessment of competences, relating them to the competences and the assessment methods)

- The student must know how to apply their knowledge to their work in a professional manner, developing and defending their arguments when solving problems of the subject (B2).
- The student must develop with a high degree of autonomy necessary learning skills to continue with the subjects of biosciences and Engineering (B5).
- The student must learn to assess the impact of their professional activity on the sustainable development of society (T3).
- The student must be able to understand and apply advanced knowledge of Biosciences and Engineering in the realization of activities in the field of Biotechnology (E3).
- Be able to use tools, systems or processes to achieve the requirements established in the activity to be carried out in the field of Biotechnology (E4).
- Be able to integrate the knowledge and tools of biotechnology to apply them to the different industrial sectors that use, develop or produce biotechnological products or processes (E6).

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QUALIFICATION (Explanation of the qualification system)

The evaluation of the subject will consider the grading of the follow-up activities (AS), the participation (P) and the final exam (EF).

The grade of the follow-up activities (AS, 30% of the final grade) will be calculated as a simple average of the activities carried out, consisting of the resolution of the questionnaires/controls and/or deliverable exercises that are carried out throughout the course. Those activities that are not delivered will be graded as 0.

The teacher at the end of the subject awards the grading of the participation (P, 5% of the final grade). The level of participation that the student has had in the overall of the activities of the subject, especially in the resolution of problems on the blackboard and in class participation (answering questions proposed by the teacher) will be taken into account.

The final exam is divided between theory (EFT, 30% of the evaluation) and problem resolution (EFP, 35% of the evaluation) and aims to assess the synthesis of the subject. The minimum grade of each part of the final exam (EFT and EFP) must be 3.5 (out of 10) and the minimum mark of the totality of the exam must at least be equal or over 4 (out of 10).

The final grade (CF) of the subject is calculated following formula:

\[ CF = 0.30 \text{ EFT} + 0.35 \text{ EFP} + 0.30 \text{ AS} + 0.05 \text{ P} \]

In the second call the AS and P grades of the course will still be considered, as well as the formula of the final grade.

In subsequent calls, for the final grade of the subject only the final exam will be considered using the following formula:

\[ CF = 0.45 \text{ EFT} + 0.55 \text{ EFP} \]

In all cases, the minimum grade to pass the subject must be at least of 5 (CF = 5).

ASSESSMENT OF THE COMPETENCES (Describe the grading system for each competence in relation with the assessment tasks)

For the evaluation of the B2 competence, the problem resolution section of the final exam will be used as an indicator.

For the evaluation of the B5 competence, the final grade for the subject will be used as an indicator.

For the evaluation of the T3 competence, the final grade of the subject will be used as an indicator.

For the evaluation of the E3 competence the indicator used will be the AS score.

For the evaluation of the E4 competence, the problem resolution section of the final exam will be used as an indicator.

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For the evaluation of the E6 competence, the final exam grade will be used as an indicator.

**BIBLIOGRAPHY** *(Recommended and accessible to the student.)*

- E. Barberà, “Problemas de biotecnología resueltos”, 2013, IQS
- E. Barberà, “Ingeniería de los procesos con microorganismos: Principios fundamentales y simulación con MATLAB®”, 2012, Editorial Académica Española

**DOCUMENT HISTORY**

**PREVIOUS REVISIONS** *(Indicate date and author / s, first the most recent one)*

**CURRENT REVISION** *(Indicate date and author / s)*
March 20th 2019, Dr. Martí Lecina

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