SUBJECT GUIDE 2020-2021

Industrial Bioprocesses

<table>
<tr><td>MODULE</td><td>CONTENT</td><td>YEAR</td><td>TERMS</td><td>CREDITS</td><td>TYPE</td></tr>
<tr><td>Elective module</td><td>Industrial Bioprocesses</td><td>3rd – 4th</td><td>1st</td><td>6</td><td>Elective course</td></tr>
<tr><td colspan="3">LECTURER</td><td colspan="3">CONTACT ADDRESS FOR TUTORSHIP
(Mail address, telephone, mail address, etc.)</td></tr>
<tr><td colspan="3" rowspan="3">Javier Miguel Ochando Pulido
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<tr><td colspan="3">TUTORING SCHEDULE</td></tr>
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<tr><td colspan="3">DEGREE WHERE THE SUBJECT IS TAUGHT</td><td colspan="3">OTHER DEGREES WHERE THIS SUBJECT COULD BE TAUGHT</td></tr>
<tr><td colspan="3">Food Science and Technology</td><td colspan="3">Chemical Engineering</td></tr>
<tr><td colspan="6">REQUERIMENTS AND RECOMENDATIONS (if needed)</td></tr>
<tr><td colspan="6">It is advisable to have completed the module in Food Technolgoy. This subject can be taken in 3rd or 4th year</td></tr>
<tr><td colspan="6">BRIEF DESCRIPTION OF THE CONTENTS</td></tr>
<tr><td colspan="6">Kinetics of enzymatic reactions. Kinetics of the microbial growth. Immobilized Biocatalysts. Bioreactors. Enzymatic reactors. Batch fermenters. Continuous fermenters. Stirring, aeration and sterilization. Separation</td></tr>
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operations.

SPECIFIC AND GENERAL SKILLS (Please refer to the report “Memoria de Verificación del Grado CTA”)

General skills: CG.01 – CG and CB1 to CB5.
Specific skills: CE.1, CE.2, CE.3, CE.6 and CE.15

OBJETIVES (REPORTED AS EXPECTED CAPABILITIES ACQUIRED FROM THE LEARNING PROCESS)

After completing this subject, the student should be able to:

- Develop phenomenological models for enzymatic and fermentation processes and estimate their reaction parameters.
- Set experimental designs for the study of an enzymatic or microbiological kinetics.
- Develop models to optimize the performance of a bioreactor.
- Develop the separation operations needed for the concentration and purification of a given product.

DETAILED SYLLABUS OF THE SUBJECT

THEORETICAL PROGRAM:

1. **Introduction to Industrial bioprocesses**. Enzymatic and fermentation processes. Industrial applications.

2. **Kinetics of enzymatic reactions**. Modelling of enzymatic reactions. Estimation of kinetic parameters. Influence of pH and temperature on enzyme activity.

3. **Kinetics of microbial growth**. Modelling of microbial growth. Yields. Estimation of kinetic parameters.

4. **Immobilized biocatalysts**. Immobilization techniques. Kinetics of immobilized biocatalysts.

5. **Bioreactors**. Mass and energy balances. Stirred tank bioreactors. Plug and flow bioreactors.

6. **Enzymatic reactors**. Influence of enzyme denaturation. Bioreactors with immobilized enzymes.

7. **Batch fermenters**. Fermentation cycle. Optimization of biomass or product yield. Semicontinous mode.

8. **Continuous fermenters**.Productivity of biomass and product. Washing out of biomass. Biomass recycle.

9. **Stirring, aeration and sterilization**. Heat transfer. Oxygen transfer. Sterilization of culture media.

10. **Separation operations**. Cell disruption. Centrifugation. Extraction. Concentration. Purification.

PRACTICAL PROGRAM: Computer-aided simulation activities related to enzymatic and fermentation kinetics.

- Activity 1. Estimation of kinetic parameters. Linear and multiple regressions. Non linear regression by minimal squared sum.
- Activity 2. Simulation of enzymatic reactors. Reaction mechanisms. Operation modes. Influence of pH and temperature on the enzyme activity.
- Activity 3. Simulation of fermenters. Effect of the initial inoculum concentration. Optimization of biomass and product yield. Washing out of biomass.

FURTHER READING

- Atkinson B. Reactores bioquímicos. Ed Reverté. 1986
- Gòdia Casablancas FJ. y cols. Ingeniería bioquímica. Ed Síntesis. 1998
- Dunn IJ. Y cols. Biological reaction engineering. Ed VCH. 1992
- Ghose TK. Bioprocess computations in biotechnology. Ellis Horwood. 1990
- Madrid A. y cols. Nuevo Manual de industrias alimentarias. AMV ediciones. 2001

WEB LINKS

www.sciencedirect.com
www.scopus.com

TEACHING METHODOLOGY

- Theoretical lectures. Skills: CG 1, 2, 4, 7, 11 y 13; CB 1, 2 y 3; CE 1, 2, 6 y 15
- Practical lectures. Skills: CG 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 y 14; CB 1, 2, 3, 4 y 5; CT 2; CE 1, 2 y 6.
- Computer-aided activities. Skills: CG 1, 2, 3, 4, 7, 8, 11 y 12; CB 1, 2, 3 y 5; CT 2; CE 1, 2 y 6.
- Specialized tutoring.

ASSESSMENT (ASSESSMENT INSTRUMENTS AND CRITERIA, MARKS)

CONTINUOUS ASSESSMENT

- 60% Written exam on theorical and practical contents (SE1). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CE 1, 2 y 6
- 10% Exam on computer activities (SE2). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CT 2; CE 1, 2 y 6
- 25% Team work activities (SE3). Skills: CG 3, 4, 5, 7, 8, 10, 11 y 14; CB 1-5; CT 2; CE 1, 2, 6 y 15.
- 5% Classroom active participation (SE4). Skills: CG 1, 2, 3, 6 y 10

FINAL EVALUATION

Comprising a single examination. Those students interested in being evaluated by this procecure should request the approbal of the director of the department two weeks after the course registration, according to the Evaluating Regulations for the students of the University of Granada (approbed by the Council 20/05/2013). This request should provide and certify the reasons for not attending regular lectures.

- 80% Written exam on the theory and practice program (SE1). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CE 1, 2 and 6. It is mandatory to obtain a minimal mark of 5 over 10.
- 20% Exam on computer skills (SE2). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CT 2; CE 1, 2 and 6. It is mandatory to obtain a minimal mark of 5 over 10.

REMEDIAL EVALUATION

Comprising a single examination, for those students who have not passed the subject in the June evaluation period.

- 80% Written exam on the theory and practice program (SE1). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CE 1, 2 and 6. It is mandatory to obtain a minimal mark of 5 over 10.
- 20% Exam on computer skills (SE2). Skills: CG 1, 2, 4, 5, 7 y 8; CB 1-3; CT 2; CE 1, 2 and 6. It is mandatory to obtain a minimal mark of 5 over 10.