2nd Year – Module: Industrial Biotechnology – Obligatory Courses

INDBIOT-01:	**BIOPROCESS ENGINEERING**
GENERAL INFORMATION	
Course Coordinator(s)	Vinko Krstanović, PhD, full prof. Kristina Mastanjević, PhD, assist. prof.
Associate(s)	
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Obligatory
Year of Study, Semester	2nd Year / 3rd Semester
Credits (ECTS)	**6**
Teaching Method (number of classes)	Lectures 30; Seminars 15; Exercises 30
Expected Number of Students in the Course	25-30
COURSE DESCRIPTION	
Course Aims	
The objective of this course is to gain basic knowledge of biotechnological processes through learning about the structure and functioning of biocatalysts, the properties of the production medium and unit operations of the upstream phase, the cultivation phase in the bioreactor and the downstream phase.	
Prerequisites for Enrolment and the Entry Competencies Required for the Course	
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Learning Outcomes at the Programme Level Contributed by the Course	
BIOTECH-1; INDBIOT-2	
Learning Outcomes at the Course Level	
After successful completion of this course students are expected to be able to: 1. Differentiate and compare different types of bioprocess: batch, feed- batch, semi-continuous and continuous bioprocesses; 2. Suggest equipment for running the selected bioprocess. 3. Select a system for monitoring and regulating bioprocesses and the type and conditions of sterilization, depending on the type of nutrient medium. 4. Calculate bioprocess performance parameters. 5. Critically evaluate different bioprocessing systems using first- and second-generation immobilized biocatalysts. 6. Predict upstream and downstream processes for the selected bioprocess.	
Course Content	
Lectures. Phases and types of biotechnological processes; microbial growth kinetics; kinetics of enzymes and immobilized enzymes; biomass cultivation; mass balance of batch, fed- batch, semi-continuous and continuous bioprocesses; microbial growth stoichiometry, and product formation; evaluation of bioprocess performance; bioprocess control and control equipment; sterilization; aeration and mixing processes; regulation and optimization of bioprocesses; bioreactor systems with immobilized biocatalysts; and bioprocess product separation processes. **Seminars**. Creating a balance sheet for preparation of batch, fed-batch bioprocess, semi-continuous and continuous bioprocess; calculating the specific growth rate of microorganisms and success of product formation. **Laboratory exercises**. Aerobic process (acetic acid production); anaerobic batch process (ethanol production); fed-batch process (bioethanol production) on a laboratory scale, and calculation of success indicators of microbial process; immobilization of yeast cells in matrix.	
Teaching Methods	

Lectures; seminars; laboratory exercises

Students' Obligations

Attendance at all forms of classes is mandatory and the students are obligated to attend all knowledge tests. The students may be absent from 30% (full-time students) and 50% (part-time students) of each of the forms of classes, provided that the absence is justified. An exercise or a seminar which has not been completed must be made up through a midterm exam.

Monitoring the Activity of the Students *(Connecting Learning Outcomes, Teaching Methods, and Grading)*

Class-related activity	ECTS	Learning outcome	Student activity	Evaluation method	Grade points	
					Min.	Min.
Attending classes	0.5	1- 6	Attendance at classes	Keeping records	2	10
Seminars	1.5	1,4	Seminar work preparation	Presentation of seminar work	10	20
Laboratory exercises	1.5	1,4-5	Practical work	Laboratory exercises report	8	20
Knowledge tests (partial tests/or final written exam)	2.5	1-6	Studying for the partial tests or final written exam	Written exams	30	50
Total	**6**				**50**	**100**

Evaluation of the written part of the final exam:

Percentage of correct answers (%)	Grade points
>95.00	50
90.00-94.99	47
85.00-89.99	45
80.00-84.99	40
75.00-79.99	38
70.00-74.99	35
65.00-69.99	33
60.00-64.99	30

Forming the final grade:
The points granted for the final exam are added to the grade points awarded during class attendance. The grading process is conducted by absolute distribution, i.e. based on total achievements, and compared to the numerical system in the following manner:
A – Excellent (5): 90-100 grade points; B – Very Good (4): 80-89.99 grade points; C – Good (3): 65-79.99 grade points; D – sufficient (2): 50-64.99 grade points

Mandatory Literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Doran PM: Bioprocess Engineering Principles, 2nd Ed., Academic Press, 2013.	1	yes
Das D, Das D, Biochemical Engineering: An Introductory	1	yes

Textbook, Jenny Stanford Publishing Pte. Ltd., 2019.		
Additional Literature		
James M L, Biochemical Engineering, eBook Version 2.2, 2006. Katoh S, Horiuchi J-i, Yoshida F, Biochemical Engineering: A Textbook for Engineers, Chemists and Biologists, 2nd Ed., Wiley-VCH Verlag GmbH & Co. KGaA, 2015.		
Quality Assurance Procedures Designed to Ensure the Acquisition of Outcomes and Competencies		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Food Technology Osijek and/or the Faculty of Medicine Osijek.		
Note		
E-learning is not included in the class quota, but it is used in teaching and it contains links to various sites and video and audio materials available on websites.		