BIOTECH-E06:	**ENZYME IMMOBILIZATION TECHNIQUES**
GENERAL INFORMATION	
Course Coordinator(s)	Ivica Strelec, PhD, full prof. Sandra Budžaki, PhD, assoc. prof.
Associate(s)	Marta Ostojčić, MSc
Study Programme	Interdisciplinary Graduate Study Programme in English: Biotechnology
Course Status	Elective
Year of Study, Semester	1st Year / 2nd Semester
Credits (ECTS)	**3**
Teaching Method (number of classes)	Lectures 15; Seminars 5; Exercises 10
Expected Number of Students in the Course	25-30

COURSE DESCRIPTION

Course Aims

The aim of this course is to provide advanced knowledge of enzyme immobilization techniques on molecular level, as well as to introduce the students with up-to-date immobilization techniques. In addition, course provides in depth understanding of molecular interactions underlying enzyme carrier interactions, enables rational planning of enzyme immobilization process, as well as acquisition of practical skills in enzyme immobilization and qualitative and quantitative evaluation of experimental data of immobilization process.

Prerequisites for Enrolment and the Entry Competencies Required for the Course

Completed undergraduate university study programme of Natural sciences (chemistry, biology), Biotechnical sciences, Biomedicine or Health.

Learning Outcomes at the Programme Level Contributed by the Course

BIOTECH-2; INDBIOT-2; INDBIOT-3

Learning Outcomes at the Course Level

After successful completion of this course students should be to:

1. Critically evaluate from start to finish the entire process of enzyme immobilization on different scales of production (from laboratory to large-scale production)
2. Recommend various techniques of enzyme immobilization
3. Plan and explain enzyme immobilization process with respect to the enzyme and carrier molecular properties and type of their interaction
4. Select and design enzyme immobilization process with respect to starting material and demands on reuse of immobilized enzyme
5. Know how to choose and use different methods for qualitative and quantitative analysis (evaluation) of enzyme immobilization process and immobilized enzyme reuse
6. Perform enzyme immobilization and critically evaluate experimental results by qualitative and quantitative analysis of immobilization process

Course Content

Lectures. Introduction to enzyme immobilization (*practical reasons for enzyme immobilization, history of enzyme immobilization, important patent of industrial applications, commercialisation of enzyme immobilization*). Techniques of enzyme immobilization (*adsorption, covalent linking, entrapment, enzyme cross-linking*). Intermolecular interactions and/or bonds between enzymes and carriers. Enzyme carriers. Immobilized enzyme properties. Evaluation of immobilization process. Application of immobilised enzymes in biotechnology, pharmacy and biomedicine.
Seminars. Production of enzyme carriers from agro-food industrial waste. Effect of immobilization on kinetic properties and stability of immobilized enzymes.
Laboratory exercises. Enzyme immobilization by adsorption, covalent linking and entrapment.

Determination of reusability of immobilized enzyme. Qualitative and quantitative evaluation of immobilization process.

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.

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.	Max.
Classes	0.25	1-6	Attendance to classes	Keeping records	2	10
Seminars	0.25	1-6	Preparation of seminar presentation	Seminar presentation	5	15
Laboratory exercises	1	3, 6	Work in laboratory	Written report	13	25
Final exam	1.5	1-6	Studying for the final exam	Written exam	30	50
Total	**3**				**50**	**100**

Table 2. Evaluation of the written part of the final exam

Percentage of correct answers (%)	Grade points
99.00 – 100.00	50
97.00 – 98.99	49
95.00 – 96.99	48
93.00 – 94.99	47
91.00 – 92.99	46
89.00 – 90.99	45
87.00 – 88.99	44
85.00 – 86.99	43
83.00 – 84.99	42
81.00 – 82.99	41
79.00 – 80.99	40
77.00 – 78.99	39
75.00 – 76.99	38
73.00 – 74.99	37
71.00 – 72.99	36
69.00 – 70.99	35
67.00 – 68.99	34
65.00 – 66.99	33
63.00 – 64.99	32
61.00 – 62.99	31
60.00 – 60.99	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
Dwevedi A, Enzyme Immobilization-Advances in Industry, Agriculture, Medicine, and the Environment, Springer International Publishing Switzerland, Zurich, 2016	-	-
Cao L, Carrier-bound Immobilized Enzymes - Principles, Applications and Design, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2006	-	-

Additional Literature

1. Guisan JM, Immobilization of enzymes and Cells, 3rd Ed., Humana Press/Springer Science+Business Media, New York, 2013
2. Minteer SD, Enzyme Immobilization and Stabilization – Methods and Protocols, 2nd Ed., Humana Press/Springer Science+Business Media, New York, 2017
3. Scientific and professional papers related to the specific areas of the course

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.