COURSE DESCRIPTION

Enzymatic Networks and Artificial Metabolism for the Production of Synthetic Compounds
Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	University Babeș-Bolyai Cluj-Napoca
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemistry
1.4. Field	Chemistry
1.5. Level of study	Doctorate
1.6. Degree programme / Qualification	Doctoral training / Doctor of Chemistry
1.7. Form of education	Full time

2. Course-related data

2.1. Course title	Enzymatic Networks and Artificial Metabolism for the Production of Synthetic Compounds			Course code	SDC-19-09
2.2. Course coordinator	Prof. habil. dr. eng. Csaba Paizs				
2.3. Seminar coordinator	Prof. habil. dr. eng. Csaba Paizs				
2.4. Year of study	I	2.5. Semester	2	2.6. Type of assessment	Exam
2.7. Course status	Optional			2.8. Course type	Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**2**	of which: 3.2. course	**1**	3.3. seminar/ laboratory/ project	**1**
3.4. Total of hours in the curriculum	24	of which: 3.5. course	12	3.6. seminar/ laboratory	**12**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					50
Additional research in the library, on subject-specific electronic platforms, and on-site					50
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					40
Tutoring (professional guidance)					40
Examinations					2
Other activities					32
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**214**	
3.8. Total hours per semester				**250**	
3.9. Number of credits				**10**	

4. Prerequisites (where applicable)

4.1. curriculum-related	None
4.2 skills-related	none

5. Specific conditions (where applicable)

5.1. course-related	None
5.2. seminar/laboratory-related	none

6.1. Competencies resulting from the completion of the degree programme[1]

Professional competencies	
Competency code	**Competency**
PC1	Advanced expertise in chemistry and doctoral-level research topics
PC4	Planning, designing, and implementing an original scientific research project, in compliance with academic ethics and integrity
PC5	Applying and developing advanced research and analytical methods; critically interpreting data and formulating innovative solutions
Transversal competencies	
Competency code	**Competency**
TC2	Advanced scientific communication in Romanian and English; collaboration in interdisciplinary and multicultural settings
TC3	Advanced digital skills for research, data analysis, and dissemination; responsible use of digital tools.

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC1	Advanced and up-to-date knowledge in chemistry and the research field; critical understanding of the scientific literature.	Applies and synthesizes advanced concepts/theories to formulate research hypotheses; justifies the choice of scientific approaches.
PC4	Advanced research methodologies: experimental design, modern synthesis and characterization techniques, analysis and validation; principles of research project management.	Designs, plans and implements a research project; applies quality and safety procedures and documents stages and data with full traceability.
PC5	Advanced strategies for data analysis, interpretation, and integration; evaluation of methodological limitations, reproducibility, and scientific impact.	Critically analyses complex data, estimates uncertainty and formulates conclusions; proposes methodological improvements and directions for research/innovation.
TC2	Scientific terminology and communication in Romanian and English; the structure of scientific articles and presentations; good citation practices.	Writes and presents scientific results in Romanian/English coherently; provides well-argued responses to comments and peer reviews.
TC3	Digital tools for research, citation, and data processing (databases, specialized software, reference managers); responsible use of digital resources.	Uses discipline-specific digital tools effectively; manages citations; uses digital resources responsibly in research activities.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Assessment of the impact of multienzymatic biocatalytic processes on viability of the chemical industry.
2. Multistep biocatalytic strategies for the production of industrially relevant chemicals.

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

3. Design of Enzymatic networks and down-stream procedures for industrial processes.
4. The ability to collect, analyze, interpret and valorize information based on the designed experiments.
Specific academic skills
1. The ability to apply advanced theories and methodologies to design strategies and to choose effective methods for the targeted scientific objective.
2. The ability to analyze critically one's own experimental data of high complexity in order to propose effective and relevant methodological approaches and research directions
3. The ability to coherently present scientific results in Romanian and English, to argue the chosen solutions, to respond in a scientifically argued manner to questions and observations

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
8.1.1-2. Principles of artificial metabolism and enzymatic networks.	Presentation, discussion, case studies	
8.1.3-4. Parallel multienzymatic reactions. Sequential (cascade) enzymatic reactions.		
8.1.5-6. Harmonization of the enzymatic activity in enzymatic networks with immobilized enzymes.		
8.1.7-8. Harmonization of the enzymatic activity in enzymatic networks (cellular biocatalysis).		
8.1.9-10. Downstream procedures for batch and flow processes.		
8.1.11-12. Industrially relevant enzymatic networks	Presentation, discussion, case studies, critical analysis	
Bibliography		
1. John Whittall, Peter Sutton: Biocatalysis and Biotransformations, 2010 John Wiley & Sons Ltd 2. Andr´es Illanes: Enzyme Biocatalysis: Principles and Applications, 2008 Springer Science Business Media B.V. 3. Pabulo H. Rampelotto: Enzymes and Their Biotechnological Applications, 2015, MDPI • Basel • Beijing • Wuhan 4. Peter Grunwald: Immobilized Biocatalysts, 2018, MDPI • Basel • Beijing • Wuhan • Barcelona • Belgrade 5. Poppe, L., Paizs, C., Tasnádi, G. “Asymmetric Enzymatic Catalysis”, in Encyclopedia of Green Chemistry vol. 3, pp. 277-294, Elsevier, 2025.		
8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
8.2.1. General discussion. Experimental activity schedule	Presentation, discussion, exercises	Individual case study of each PhD-student based on individual doctoral research topics, experimental activity; 2 hours each 2 weeks
8.2.2. Case studies for parallel multienzymatic reactions.	Presentation, discussion, exercises	
8.2.3. Case studies for sequential multienzymatic reactions.	Presentation, discussion, exercises	
8.2.4. Enzymatic networks-case studies	Presentation, discussion, exercises	
8.2.5. Immobilization techniques. Coexpression of multiple enzymes	Presentation, discussion, exercises	
8.2.6. Biocatalytic reactions wih enzymatic networks	Presentation, discussion, exercises	
Bibliography • Scientific articles • Data bases • Official webpages		

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Assessment of knowledge	Oral presentations	70%
9.5. Seminar/ laboratory	Activity during seminars	Discussions, answers to questions	30%
9.6 Minimum standard for passing			
Satisfactory			

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label

								
○	○	○	○	○	○	○	○	X
								No label applies
○	○	X	○	○	○	○	○	○

Date of entry:
23.01.2026

Signature of course coordinator

Signature of seminar coordinator

Date of approval in CDSC:

Signature of the Director of the DSC

Prof. dr. Niculina Daniela Hădade

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*