COURSE DESCRIPTION

Protein and genetic engineering

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeş-Bolyai University
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Chemistry
1.4. Field	Chemistry
1.5. Level of study	Master
1.6. Degree programme / Qualification	Chemical biology in life and medical sciences
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	Protein and genetic engineering			Course code	CME6104
2.2. Course coordinator	Conf. Dr. Laszlo Csaba Bencze				
2.3. Seminar coordinator					
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Core subject

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

3.1. Hours per week	**2**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**0**
3.4. Total hours in the curriculum	28	of which: 3.5 course	28	3.6 seminar/laborator	**0**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
3.5.1. Learning using manual, course support, bibliography, course notes (SA)					20
3.5.2. Additional documentation (in libraries, on electronic platforms, field documentation)					20
3.5.3. Preparation for seminars/labs, homework, papers, portfolios and essays					10
3.5.4. Tutorship					16
3.5.5. Evaluations					4
3.5.6. Other activities:					--
3.7. Total individual study hours	**70**				
3.8. Total hours per semester	**98**				
3.9. Number of ECTS credits	**4**				

4. Prerequisites (where applicable)

4.1. curriculum-related	Fundamentals of recombinant protein technology, DNA analysis
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. for the course	• Video logistic support, MS Teams platform, Teaching board • Students will not use mobile phones during the course
5.2. for the seminar /lab activities	• The deadline for submitting assignment results will be agreed upon between the seminar/laboratory coordinator and the students. Delays will not be accepted unless justified by valid reasons. • In the case of late submission, the grade will be penalized by 0.5 points per day of delay.

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

[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.

Professional competencies	
Competency code	**Competency**
PC1	Formulating solutions for solving complex issues of biochemistry and applications of chemistry and its methods and tools in biological systems based on the knowledge and application of advanced concepts, methods from the field of biochemistry, genetics, molecular biology, and bioinformatics.
PC3	Development and application of the recombinant protein technology for the laboratory or microproduction scale protein isolation.
Transversal competencies	
Competency code	**Competency**
TC2	Familiarization with new scientific research strategies: systematic research of specialized literature, design and practice of experiments.
TC3	Designing, planning and performing an individual scientific, multidisciplinary research project.

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**
CP1, CP6	1. Knowledge of advanced bioanalytical techniques for understanding of specific interactions in biological systems.	1. Creative use of knowledge of the bioanalytical techniques for the structural and functional analysis of biomacromolecules.
CP6	1. The student/graduate knows the basic principles of a (bio)process, the stages of technology development, and methods for separating useful products. 2. The student/graduate knows the basic principles of a recombinant DNA technology, genetic engineering and the stages of technology development for the production of proteins	1. The student/graduate proposes technologies for obtaining useful products, including their separation/purification steps. 2. The student/graduate proposes technologies for obtaining useful protein products, including their separation/purification steps.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Understanding and comprehending fundamental concepts in genetic and protein engineering, including essential biological processes and modern technologies used in analysis.
2. Identifying and utilizing specific concepts, methods, and strategies to solve problems related to optimizing protein structure and function through genetic engineering techniques.
3. Applying genetic manipulation and molecular optimization methods to develop mutant proteins/enzymes with enhanced properties.
4. Designing and conducting experiments to optimize protein structure and function using genetic and protein engineering methods.
5. Critically evaluating and applying principles, methods, and specific techniques for generating and characterizing mutant protein variants with optimized properties in the laboratory.
Specific academic skills
1. The capacity to design and execute a protein engineering experiment at a laboratory scale,
2. The ability to interpret experimental data regarding enzyme fitness, enzyme stability, clone library quality, etc
3. Design and perform mutagenesis experiments to obtain focused or large directed evolution based mutant protein libraries

[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.

8. Contents

8.1 Course	Teaching methods	Remarks
8.1.1.1. Course presentation. Introduction to the concept of genetic engineering and protein engineering. Review of basic concepts related to the processes of replication, transcription, and *in vivo* translation. The PCR technique.	Lecture, explanation, conversation, exemplification, debate.	
8.1.2. Techniques used for gene expression analysis – use of reporter genes, tags for purification and detection. Techniques used for transcription analysis – Northern Blot, Real-time PCR.	Lecture, explanation, conversation, exemplification, debate.	
8.1.3. Techniques used for translation analysis – Western blot, ELISA, protein electrophoresis, etc.	Lecture, explanation, conversation, exemplification, debate.	
8.1.4. Introduction to cloning methods – general cloning schemes, cloning vectors, restriction enzymes, protein expression vectors.	Lecture, explanation, conversation, exemplification, debate.	
8.1.5. Generation of DNA libraries – complementary DNA (cDNA) libraries, targeted cloning, etc.	Lecture, explanation, conversation, exemplification, debate.	
8.1.6. DNA sequencing methods – Sanger dideoxy method, fluorescent dyes, and capillary electrophoresis for automated sequencing.	Lecture, explanation, conversation, exemplification, debate.	
8.1.7. DNA sequencing methods – Next Generation Sequencing (NGS) methods: Illumina (bridge PCR method, emulsion PCR method). Third-generation sequencing methods: NanoPore method.	Lecture, explanation, conversation, exemplification, debate.	
8.1.8. Introduction to the concept of protein engineering. Rational protein engineering and site-directed mutagenesis as corresponding tools.	Lecture, explanation, conversation, exemplification, debate.	
8.1.9. Semi-rational protein engineering techniques. Iterative Saturation Mutagenesis (ISM); CASTing.	Lecture, explanation, conversation, exemplification, debate.	
8.1.10. Directed evolution of proteins – use of mutator strains and plasmids, error-prone PCR, DNA shuffling.	Lecture, explanation, conversation, exemplification, debate.	
8.1.11. Directed evolution of proteins – automated and semi-automated high-throughput selection/screening methods.	Lecture, explanation, conversation, exemplification, debate.	
8.1.12. Protein engineering – Case studies – development of thermostable proteases, development of proteins with new functions.	Lecture, explanation, conversation, exemplification, debate.	
8.1.13. Gene editing through CRISP/CAS.	Lecture, explanation, conversation, exemplification, debate.	
8.1.14. Applications and ethic issues related to gene editing	Lecture, explanation, conversation, exemplification, debate.	

Bibliography:

1. *Stefan Lutz, Uwe Bornscheuer, Protein Engineering Handbook Volume 1-2, 2008, 2009, Wiley-VCH*
2. *Glick, B.; Pasternak, J.; Molecular biotechnology, ASM Press, Washington, 2003 – research laboratory 54;*
3. *Course material*

9. Evaluation

Type of activity	9.1 Evaluation criteria[3]	9.2 Evaluation methods[4]	9.3 Percentage

[3] 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.

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

			in the final grade
9.4. Course	Understanding, assimilating and knowing the information content. The ability to use the information in a new context. Knowing the information content. The ability to use the information in a new context both theoretically and practically.	Ora Exam – Access to the exam is conditional on completing the and submitting the individual project at the deadline agree by both coordinator and students. Participation at minimum 40% of the courses is mandatory for participating at the exam. Exam fraud is punishable by expulsion, in accordance with the ECTS regulations of UBB.	100%
9.6 Minimum standard for passing			
✓ Minimum condition for passing the exam: grade 5 (five) the exam and for the individual project			

10. SDG labels (Sustainable Development Goals)[5]

	○	Sustainable Development Generic Label

								
○	○	◉	◉	○	○	○	○	◉
								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
22.04. 2026

Signature of course coordinator

Conf. Dr. Laszlo Csaba Bencze

Signature of seminar coordinator

Conf. Dr. Laszlo Csaba Bencze

Date of approval in the department:
24.04.2026

Signature of the head of department
Prof. Dr. Eng. Monica Ioana TOȘA

[5] 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."*