COURSE DESCRIPTION

Modern Biochemical and Biophysical Methods

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University
1.2. Faculty	Biology and Geology
1.3. Department	Molecular biology and biotechnology
1.4. Field	Biology
1.5. Level of study	Master
1.6. Degree programme / Qualification	Molecular Biotechnology / Master
1.7. Form of education	Full time

2. Course-related data

2.1. Course title	Modern biochemical and biophysical methods			Course code	BME1306
2.2. Course coordinator	Lect. Dr. Valentin-Florian Rauca				
2.3. Seminar coordinator	Lect. Dr. Valentin-Florian Rauca				
2.4. Year of study	II	2.5. Semester	3	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			Compulsory	Specialized subject

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

3.1. Number of hours per week	4	of which: 3.2. course	2	3.3. seminar/ laboratory/ project	2
3.4. Total of hours in the curriculum	154	of which: 3.5. course	28	3.6. seminar/ laboratory	28
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					30
Additional research in the library, on subject-specific electronic platforms, and on-site					24
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					24
Tutoring (professional guidance)					16
Examinations					4
Other activities					0
3.7. Total individual study hours				98	
3.8. Total hours per semester				154	

3.9. Number of ECTS credits	6

4. Prerequisites (where applicable)

4.1. curriculum-related	Biochemistry; Biophysics; Molecular Biology.
4.2 skills-related	Use of laboratory equipment; application of modern techniques for biochemical and biophysical analysis of biological samples in medical, environmental, and research laboratories.

5. Specific conditions (where applicable)

5.1. course-related	Audio-video support; online meeting platform, when necessary.	
5.2. seminar/laboratory-related	Attendance in at least 90% of the practical laboratory / seminar activities is a condition for participation in the written exam.	

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

Professional competencies	
Competency code	**Competency**
PC1	Apply laboratory safety procedures, conduct interdisciplinary research activities, apply scientific methods, manage research data, and draft scientific, academic, and technical documentation.
PC2	Develop scientific theories, conduct scientific research, manage research data, and apply research ethics and scientific integrity principles in research activities.
PC4	Conduct genome research, perform laboratory tests, and evaluate genetic data.
Transversal competencies	
Competency code	**Competency**
TC1	Promote knowledge transfer, conduct interdisciplinary research, and manage findable, accessible, interoperable, and reusable data.
TC2	Interact professionally in research and professional environments and promote open innovation in research.

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

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC4	The student explains the theoretical principles of modern biochemical and biophysical analysis techniques.	The student uses modern instrumental techniques (spectroscopy, chromatography, advanced microscopy) for the analysis of biomolecules.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student explains the physicochemical principles underlying modern biochemical and biophysical techniques used to analyze biomolecules and biological structures.
2. The student describes the operating principles, applicability, and limitations of modern methods such as fluorescence microscopy, atomic force microscopy, HPLC, FTIR, Raman spectroscopy, electrophoresis, and western blotting.
3. The student correlates the type of experimental information delivered by each method with the investigated level of biological organization (molecular, subcellular, cellular).
4. The student explains the relevance of modern biochemical and biophysical methods for biomedical, clinical, and interdisciplinary research.
Specific academic skills
1. The student appropriately selects and uses protocols and modern instrumental techniques for the analysis of biological samples in experimental contexts.
2. The student processes, interprets, and critically compares experimental data generated by fluorimetric, chromatographic, spectroscopic, and electrophoretic methods.
3. The student writes and communicates concise experimental results using appropriate scientific terminology and observing safety, ethics, and scientific integrity standards.

8. Contents

8.1. Course	Teaching and learning methods	Remarks
1. Introduction to the fluorimetric study of cells and biomolecules.	Video-assisted frontal lecture; recap of prior knowledge; conversation.	2 hours; students recall the principle of fluorescence. Bibliography: [1], [2], [9]
2. Fluorescence microscopy: principles, techniques, and equipment.	Frontal lecture with video support; modeling; problem-based and discovery learning.	2 hours. Bibliography: [1], [2], [9]
3. Biological applications of fluorescence microscopy: highlighting cellular structures and biomolecules using fluorescent markers.	Frontal lecture with video support; conversation; modeling; discovery learning.	2 hours. Bibliography: [1], [2], [9]
4. Scanning probe microscopy. Probe-specimen interaction and applications in the evaluation of biological samples.	Frontal lecture with video support; conversation; modeling; problematization.	2 hours. Bibliography: [3], [9]
5. Atomic force microscopy: constructive elements, electronic control, signal acquisition and processing.	Frontal lecture with video support; conversation; modeling; discovery learning.	2 hours. Bibliography: [3], [9]
6. 3D morphological imaging, 2D representation, nano-dimension measurements, relative positioning, and haptically mediated mechanical nanomanipulation.	Frontal lecture with video support; conversation; modeling; problem-based learning.	2 hours. Bibliography: [3], [9]

7. General notions of chromatography; chromatography principles and types. High Performance Liquid Chromatography (HPLC): principles and types of HPLC techniques.	Frontal lecture with video support; conversation; problematization; discovery learning.	4 hours. Bibliography: [7], [8], [9]
8. Interaction of electromagnetic radiation with matter: general notions of spectroscopy.	Frontal lecture with video support; conversation; knowledge recap.	2 hours. Bibliography: [4], [5], [6], [9]
9. FTIR and Raman methods: principles, instrumentation, and biological/biomedical applications. PCA analysis of FTIR spectra.	Frontal lecture with video support; conversation; problematization; discovery learning.	4 hours. Bibliography: [4], [5], [6], [9]
10. Electrophoresis: general principle and types of electrophoresis. Western blotting: principle, applications, and technical variants.	Frontal lecture with video support; conversation; problematization; discovery learning.	6 hours. Bibliography: [7], [8], [9]
11. Western blotting- principle, aplications and technique types	Frontal lecture with video support; conversation; problematization; discovery learning	2 hours . Bibliography [7], [8], [9]
12. FTIR and Raman: principles and devices description	Frontal lecture with video support; conversation; problematization; discovery learning.	2 hours, Bibliography: [4], [5], [6], [9]
13. Biological and biomedical applications of FTIR and Raman methods. PCA analysis of FTIR spectra	Frontal lecture with video support; conversation; problematization; discovery learning.	2 hours, Bibliography Bibliografie: [4], [5], [6], [9]

Bibliography

[1] Spring, K.R. (2003) Fluorescence microscopy. in Encyclopedia of Optical Engineering, Marcel Dekker, New York, New York, pag. 548-555.
[2] Lichtman, J.W., Conchello, J.A. (2005) Fluorescence microscopy. *Nature Methods* **2**: 910-919.
[3] Mironov, L.V. (2004) Fundamentals of scanning probe microscopy. Russioan Academy of Sciences, Institute of Physics of Microstructures, Nizhniy Novgorod.
[4] Leopold, N. (2009) Surface-enhanced Raman spectroscopy. Selected Applications, Editura Napoca Star, Cluj-Napoca.
[5] Iliescu, T., Cîntă Pînzaru, S., Maniu, D., Astilean, S., Grecu, R. (2002) Aplicaţii ale spectroscopiei vibraţionale, Ed. Casa Cărţii de Stiinţă, Cluj-Napoca.
[6] Siebert, F, Hildebrandt P. (2008) Vibrational Spectroscopy in Life Science, Wiley-VCH.
[7] Keith, W. (2010) Principles and techniques of biochemistry and molecular biology, Cambridge University Press, pag. 433-477.
[8] Robyt, J.R., White, B.J. (1990) Biochemical techniques Theory and Practice, Waveland Press, pag. 73-128.
[9] Suport de curs (prezentări Powerpoint) în format electronic.
(Cărţile şi suportul de curs se găsesc în bibliotecile Facultăţii de Biologie şi Geologie, respectiv Biblioteca Facultăţii de Fizică)

8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
1. Presentation of the laboratory; working principles of applied fluorescence techniques. DNA staining with DAPI for cell visualization and counting.	Face-to-face seminar; explanation; conversation; demonstrative practical activity.	2 hours

2. Staining with Nile red to highlight lipid inclusions	Face-to-face seminar; explanation; conversation; demonstrative practical activity.	2 hours
3.Introduction to the AFM microscope, including its use in “contact mode” and “non-contact mode” for scanning standard samples. Haptic-assisted mechanical nanomanipulation in “contact mode”	Face-to-face seminar; explanation; conversation; demonstrative practical activity.	6 hours
4. HPLC quantitative determination of an oxidative stress marker in plasma (malondialdehyde).	Face-to-face seminar; explanation; conversation; demonstrative practical activity.	4 hours
5. Analysis of the hydrogen atom spectrum; X-ray fluorescence analysis; UV-Vis spectroscopy.	Explanation; conversation; demonstrative practical activity.	6 hours
6. Semi-quantitative determination of the transcription factor NF-kB by denaturing polyacrylamide gel electrophoresis followed by western blotting.	Face-to-face seminar; explanation; conversation; demonstrative practical activity.	6 hours
7. Laboratory work evaluation.	Written colloquium.	2 hours
Bibliography		
(1) Collection of protocols for each laboratory work, available in the department library.		

9. Evaluation

Type of activity	9.1 Evaluation criteria.	9.2 Evaluation methods	9.3 Percentage in the final grade
9.4. Course	Assimilation of the information content and understanding of the theoretical principles underlying modern biochemical and biophysical techniques.	Written examination	50%
9.5. Seminar/ laboratory	Adequate use of concepts to explain the biomedical and experimental applications of the presented methods.	Formative assessment during the semester	—
	Laboratory working skills, correct use of protocols and modern analytical equipment.	Practical assessment during laboratory activities	20%
30%			

10. SDG labels (Sustainable Development Goals)

		Sustainable Development Generic Label

								
		X						
								No label applies
			X	X				X

Date of entry:
09.04.2026

Signature of course coordinator
Lect. Dr. Valentin-Florian Rauca

Signature of seminar coordinator
Lect. Dr. Valentin-Florian Rauca

Date of approval in the department:
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Signature of the head of department
Conf. Dr. Beatrice Simona Kelemen