SYLLABUS

INTEGRATIVE BIOINFORMATICS

Academic year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babeș-Bolyai University
1.2. Faculty	Faculty of Biology and Geology
1.3. Department	Doctoral School of Medical and Health Sciences
1.4. Field of study	Medicine
1.5. Study cycle	Doctorate, 4 years
1.6. Study programme/Qualification	PhD in Medicine / Medic
1.7. Form of education	Full-time

2. Information regarding the discipline

2.1. Name of the discipline	**Integrative Bioinformatics**					Discipline code	**BDR1106**
2.2. Course coordinator				Cojocaru Vlad, PhD Habil., CS I Banciu Horia Leonard, PhD Habil., Prof.			
2.3. Seminar coordinator				Cojocaru Vlad, PhD Habil., CS I Banciu Horia Leonard, PhD Habil., Prof.			
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Discipline regime	Optional

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

3.1. Hours per week	**4**	of which: 3.2 course	**1**	3.3 seminar/laboratory	**3**
3.4. Total hours in the curriculum	48	of which: 3.5 course	12	3.6 seminar/laborator	**36**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
3.5.1. Learning using manual, course support, bibliography, course notes (SA)					30
3.5.2. Additional documentation (in libraries, on electronic platforms, field documentation)					30
3.5.3. Preparation for seminars/labs, homework, papers, portfolios and essays					30
3.5.4. Tutorship					24
3.5.5. Evaluations					4
3.5.6. Other activities					9
3.7. Total individual study hours	**127**				
3.8. Total hours per semester	**175**				
3.9. Number of ECTS credits	**7**				

4. Prerequisites (if necessary)

4.1. curriculum	Genetics, Biochemistry, Biophysics, Cell and molecular biology	
4.2. competencies	Average computer skills	

5. Conditions (if necessary)

5.1. for the course	Beamer, blackboard; Internet connection; Online meeting platform	•
5.2. for the seminar /lab activities	Attendance of at least 4 course/lecture activities. Attendance of 90% of practical/ seminar classes, Computers, specific development environment	•

6. Specific competencies acquired

Professional/essential competencies	• Ability to use Linux and command line interfaces in life sciences; • Development of the ability to generate, integrate, and analyse sequence data for life sciences; • The ability to use bioinformatics databases, prediction, analysis and visualization tools to model and predict protein structures and protein-nucleic acid complexes; • The ability to use basic methods for molecular dynamics simulations • The ability to use bioinformatics databases, prediction, analysis and visualization tools to infer the diversity and functionality of microbial genomes; • Development of the capacity for analysis, synthesis and communication of specialized scientific information
Transversal competencies	• Acquiring the necessary information to complete a doctoral thesis in Biology field in which generation, processing and analysis of high-throughput data is central. • Carrying out a research project with all that implies the use of specific concepts, the selection and application of study methods, the interpretation of data, to the communication of results.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Acquiring advanced skills in the use and development of bioinformatics tools for the integrative analysis of structural and genomic data, with applications in biology and biomedicine.
7.2 Specific objective of the discipline	• Familiarizing with computational environments and bioinformatics tools used in structural and genomic analysis, including Linux and specialized software for visualizing and modeling biomolecules. • Applying molecular modeling and molecular dynamics simulation methods to predict the structure and interactions of biomolecules, contributing to the understanding of biological mechanisms at the atomic level. • Analyzing and interpreting genomic data through sequencing, assembly, annotation, and visualization technologies, using databases and computational methods for studying biodiversity and the microbiome.

8. Content

8.1 Course	**Teaching methods**	**Remarks**
Structural Bioinformatics (part I) Introduction to Linux	Interactive exposure Presentation Explanation Practical examples Case-study discussions	Hybrid teaching: up to 40% onsite and up to 60% online classes
Structural Bioinformatics (part II) Visualization and analysis of biomolecular structures (e.g. proteins, nucleic acids)		
Structural Bioinformatics (part III) Molecular modelling (prediction of biomolecular structures, structure-based design)		
Structural Bioinformatics (part IV) Molecular docking, molecular dynamics simulations, free energy calculations		
Environmental Bioinformatics Elements of genomics, genomic projects, and databases. Genomic sequencing technologies; Quality control and read alignment; Genome assembly and comparison of assembly methods; Genome visualization tools: Dedicated genomic databases; Genome annotation; Taxonomic prediction of genomes		

Bibliography

1. Keith J.M., Bioinformatics. Vol. 1: Data, sequence analysis, and evolution. New York : Humana Press, 2017.. In: Bioinformatics, vol. Vol. 1
2. Keith J.M., Bioinformatics. Vol. 2: Structure, function, and applications. New York : Humana Press, 2017.. In: Bioinformatics, vol. Vol. 2,
3. Leach, A.R. Molecular modelling: principles and applications. Pearson education.2001.
4. Pevzner P., Bioinformatics for biologists. Cambridge ; New York : Cambridge University Press, 2013

5. Stryer L., Biochemistry. New York : W. H. Freeman and Company, 1995\
6. Schlick T., Molecular modeling and simulation : an interdisciplinary guide. New York, Springer, 2010.
7. Xiong J., Essential bioinformatics. New York : Cambridge University Press, 2006
References (1-2, 4-5, 7) are available in printed format at the libraries of the Faculty of Biology and Geology. Reference (3) is available upon request from the class tutor. Reference (6) is available in printed format at the library of the Faculty of Chemistry and Chemical Engineering.

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
Study cases and exercises in structural bioinformatics (Modeling of three-dimensional structures of biomacromolecules; Comparison of 3D structures; Modelling and visualization of molecular dynamics; Data validation, integration and comparison)	Interactive explanations Explanation Conversation Study case-based learning	Hybrid teaching: up to 50% onsite and up to 50% online classes
Study cases and exercises in environmental bioinformatics: analysis of model genomes of microorganisms using online bioinformatics tools		
Presentation of a relevant scientific article	Active learning	
Testing the acquired practical skills	Evaluation	

Bibliography
Collection of research articles available in digital format at the libraries of the Faculty of Biology and Geology and `Lucian Blaga` Central University Library, Cluj-Napoca.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course approaches essential theoretical and practical skills for a career in academia, public or private research and development institutes, as well as in industries based on the bioinformatic analysis of structural and genomic data.
- The course is included in the curricula of similar specializations at universities in the United States and Europe.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of concepts and methods from the topics of the course	Written exam	40%
10.5 Seminar/laboratory	Ability to clearly, concisely and effectively communicate the key points of an individually assigned research paper		20%
	Knowledge of specific tools/methods in structural/environmental bioinformatics		40%
10.6 Minimum standard of performance			

11. Labels ODD (Sustainable Development Goals)

SDG 3. Good health and well-being

Date: Signature of course coordinator Signature of seminar coordinator

Cojocaru Vlad, PhD Habil., CS I Cojocaru Vlad, PhD Habil., CS I

Banciu Horia Leonard, PhD Habil., Prof. Banciu Horia Leonard, PhD Habil., Prof.

Date of approval: Signature of the head of department