COURSE DESCRIPTION

MOLECULAR MEDICAL BIOLOGY

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	"Babeş-Bolyai" University Cluj-Napoca
1.2. Faculty	Faculty of Medical and Health Sciences
1.3. Department	Department of Medical and Health Sciences
1.4. Field	Biology
1.5. Level of study	4 semesters
1.6. Degree programme / Qualification	Medical Biology/Master of Medical Biology
1.7. Form of education	With frequency

2. Course-related data

2.1. Course title	Medical Molecular Biology (in English)			Course code	BME6203
2.2. Course coordinator	Dr. Kovacs Levente, assistant professor				
2.3. Seminar coordinator	Dr. Kovacs Levente, assistant professor				
2.4. Year of study	1	2.5. Semester	2	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. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**4**
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)					40
Additional research in the library, on subject-specific electronic platforms, and on-site					30
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					24
Tutoring (professional guidance)					2
Examinations					2
Other activities					0
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**98**	
3.8. Total hours per semester				**154**	
3.9. Number of credits				**6**	

4. Prerequisites (where applicable)

4.1. curriculum-related	
4.2 skills-related	

5. Specific conditions (where applicable)

5.1. course-related	Genetics, Applied molecular biology
5.2. seminar/laboratory-related	Knowledge on key concepts of molecular biology and genetics

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

Professional competencies	
Competency code	**Competency**

PC1	Correct application of laboratory techniques used in medical diagnostics (biochemistry, hematology, immunology, microbiology, molecular biology), in accordance with standardized protocols
PC2	Operation and maintenance of laboratory equipment (automated analyzers, centrifuges, PCR systems, microscopes), including calibration and performance validation.
PC3	Ability to critically analyze scientific data, evaluate modern methods and technologie
Transversal competencies	
Competency code	**Competency**
TC1	Ability to collaborate within a multidisciplinary team to improve workflow and service quality
TC3	Ability to communicate effectively about results, procedures, and technical issues

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**
PC1	Acquisition of advanced knowledge regarding the structure and function of genetic material, the molecular mechanisms underlying human diseases, and the principles of molecular diagnosis and therapy.	Ability to analyse, integrate and apply concepts and information from medical molecular biology in the interpretation of physiological and pathological processes, using scientific reasoning and critical thinking.
PC2	Knowledge of the principles, stages and limitations of molecular biology methods used in biomedical research and diagnosis (PCR, electrophoresis, sequencing, bioinformatic analyses).	Ability to design and perform experiments, to process, analyse and interpret experimental data, and to use domain-specific bioinformatics and computational tools.
PC5	Advanced knowledge regarding gene and chromosomal mutations, inheritance mechanisms, chromosomal abnormalities, and the genetic basis of hereditary diseases and cancer.	Ability to phenotypically recognise genetic and chromosomal syndromes, to interpret karyotypes and sequence variants according to international nomenclature, and to correlate genetic alterations with clinical manifestations.
TC2	Knowledge of the principles and applications of modern molecular genetics and cytogenetic techniques used for genotyping and diagnosis of genetic disorders (PCR, qPCR, sequencing, cytogenetic analyses).	Ability to apply laboratory techniques for genotype determination, to interpret sequencing results, to construct and analyse pedigrees, and to calculate probabilities of inheritance of genetic traits.
TC3	The student understands the cellular and molecular mechanisms involved in cancer initiation, progression, and metastasis, as well as the principles of molecular cancer diagnostics.	The student is able to interpret data obtained using cellular and molecular biology techniques in oncology and to develop relevant experimental designs

7. Subject-specific learning outcomes (referred to by each subject coordinator across the range of competencies and learning outcomes at the level of the degree programme)

Knowledge and comprehension
Acquisition of advanced knowledge regarding the structure and function of genetic material, the molecular mechanisms underlying human diseases, and the principles of molecular diagnosis and therapy.
Knowledge of the principles, stages and limitations of molecular biology methods used in biomedical research and diagnosis (PCR, electrophoresis, sequencing, bioinformatic analyses).
Advanced knowledge regarding gene and chromosomal mutations, inheritance mechanisms, chromosomal abnormalities, and the genetic basis of hereditary diseases and cancer.
Knowledge of the principles and applications of modern molecular genetics and cytogenetic techniques used for genotyping and diagnosis of genetic disorders (PCR, qPCR, sequencing, cytogenetic analyses).
The student understands the cellular and molecular mechanisms involved in cancer initiation, progression, and metastasis, as well as the principles of molecular cancer diagnostics.
Specific academic skills
Ability to analyse, integrate and apply concepts and information from medical molecular biology in the interpretation of physiological and pathological processes, using scientific reasoning and critical thinking.

Ability to design and perform experiments, to process, analyse and interpret experimental data, and to use domain-specific bioinformatics and computational tools.
Ability to phenotypically recognise genetic and chromosomal syndromes, to interpret karyotypes and sequence variants according to international nomenclature, and to correlate genetic alterations with clinical manifestations.
Ability to apply laboratory techniques for genotype determination, to interpret sequencing results, to construct and analyse pedigrees, and to calculate probabilities of inheritance of genetic traits.
The student is able to interpret data obtained using cellular and molecular biology techniques in oncology and to develop relevant experimental designs

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks**
Introduction into the Molecular Biology. Definition. Basic Concepts. The Brief History of the Molecular Biology. The Structure and Functions of the Nucleic Acids. (1: 1-48, 2: 51-73, 4: 1-12, 23-37)	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Isolation and Purification of Nucleic Acids. Isolation of DNA and RNA. Organic and Inorganic Isolation Methods. Solid Phase Extraction. Determination of the Purity and Concentration of the Nucleic Acids. Electrophoresis. Spectrophotometry. Fluorometry. (2: 567-570, 4: 69-86)	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Separation of Nucleic Acids with Electrophoresis. Pulsed Field Gel Electrophoresis (PFGE). Polyacrylamide Gel Electrophoresis. Capillary Gel Electrophoresis. Buffer Systems. Nucleic Acid Dyes. (2: 570-574, 582-588, 4: 87-101).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Nucleic Acid Modifying Enzymes. Nucleases. Secondary Modifying Enzymes. Ligases. Restriction Endonucleases. Polymerases. Tertiary Modifying Enzymes. (1: 50-74, 2: 600-610).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Molecular Cloning of the DNA. Creating of Recombinant DNA. Cloning, Transcription and Expression Vectors. Amplification of the Recombinant DNA. (1: 50-74, 2: 610-631)	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Nucleic Acid and Proteine Hybridization Technologies. Southern Blot. Northern Blot. Western Blot. Eastern Blot. Nucleic Acid Probes. Protein Probes. Classical and Modern Detection Methods. Interpretation of the Results. (1: 50-74, 2: 590-595, 4:102-122).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Modern Hybridization Methods. Dot/Slot – Blot. Macroarray and Microarray Technologies. DNA Chip. Karyotyping. Fluorescence in situ Hybridization (FISH). Interphase and Metaphase FISH.	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours

(2: 595-598, 709-716, 4:122-127,175-183)		
DNA Amplification Technologies. Polymerase Chain Reaction (PCR). Simple PCR Technology. Components of a Typical PCR Reaction. PCR Programs. Primers. Thermocyclers. PCR Modifications: multiplex-PCR, reverse transcriptase PCR, nested PCR, real time PCR. (2: 634-661, 4: 130-151).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Classical and Modern DNA Sequencing Methods. Direct Sequencing: Maxam-Gilbert and Sanger Methods. Pyrosequencing. Bisulfite Sequencing. Emulsion and Bridge PCR. Next Generation Sequencing. NGS Systems. (1:50-74, 2: 662-680, 686-690, 4:222-238).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Genomics and Proteomics. Basic Concepts. Genome Projects. Human Genome Project. Clinic Genome and Exome Sequencing. Human Proteome Project. Omics. (1: 759-826, 2: 680-686, 690-693, 4:240-244).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Isolation and Purification of Proteins. Identification and Sequencing of Proteins. (2: 717-744).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Molecular Diagnostics in Human Identification, Genetics and Oncology. Single- nucleotide Mutations (SNP). Polynucleotide Polymorphisms. RFLP Technology. STR Typing by PCR. FBI CODIS Database. Epigenetic Alterations. Single-gene Diseases: Leiden Mutation, Hemochromatosis, Cystic Fibrosis. Molecular Oncology. EGFR, K-ras, BRCA1 and BRCA2 (1: 759-826, 493-498, 4:249-255, 342-355).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Molecular Diagnostics in Bacteriology and Virusology. The Importance of Molecular Diagnostics of the Microorganisms. Sampling and Preparation of Samples. Control Processes and Quality Assurance. Melting Point. Infection Diagnostics in the Respiratory and Urinary tracts. (1: 759-826, 4:289-305)	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Gene Therapy. Gene Attenuation and Knock-out Technologies. (1: 759-826).	•Interactive exposure •Explanation •Conversation •Didactical demonstration	2 hours
Bibliography Obligatory bibliography: *1.Weaver, R. F.: Molecular biology, McGraw-Hill, New York, 2012 – Zoological Library, code: 18399*		

2. Clark, D. P.: Molecular biology, Elsevier Academic Press, New York, 2005 – Animal Physiology Library, code: 1391, Zoological Library, code: 17878
3. Sambrook, J.: Molecular cloning: a laboratory manual, Cold Spring Harbor Laboratory Press, Plainview, 1989 – Zoological Library, code: 16255
4. Buckingham, L.: Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, F.A. Davis Company, Philadelphia, 2012 – Animal Physiology Library, code:1542

Optional bibliography:
1. McPherson, R. A., Pincus, M. R.: Henry's clinical diagnosis and management by laboratory methods, Elsevier Saunders, Philadelphia, 2011 – Animal Physiology Library, code: 1580
2. Weaver, R. F., Hedrick, Ph. W.: Genetika, Panem, Budapest, 2000 – Zoological Library, code: 17084.

8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Molecular Biology Laboratory Organization. Work Protection Rules and Risk Management. 1: A1.1; 2: 1).	Interactive exposure. Explanation Conversation.	2 hours
Isolation and Purification of DNA from Clinic Probes. Determination of DNA Concentration and Purity (1: 5.1, 6.1; 2: 2, 3).	Interactive exposure. Explanation Conversation. Experimental Demonstration.	8 hours
DNA Amplification Methods. PCR. Separation of DNA Fragments Using Gel electrophoresis (1: 5.1; 2: 4,5).	Interactive exposure. Explanation Conversation. Experimental Demonstration.	8 hours
Oligonucleotide Primer Design (2: 6).	Interactive exposure. Explanation Conversation. Experimental Demonstration.	2 hours
Analysis of DNA Sequences. Visualization, Assembling and Identification of DNA fragments. (1: A11.1; 2: 7).	Interactive exposure. Explanation Conversation. Experimental Demonstration.	2 hours
Molecular diagnostics Seminary I.	Interactive exposure. Explanation Conversation.	2 hours
Molecular diagnostics Seminary II.	Interactive exposure. Explanation Conversation.	2 hours
Make up session/Review session.	Interactive exposure. Explanation Conversation.	2 hours

Bibliography
1. Sambrook, J.: Molecular cloning: a laboratory manual, Cold Spring Harbor Laboratory Press, Plainview, 1989 – Zoological Library, code: 16255
2. Jakab, E.: Medical Molecular Biology – Laboratory Practices, 2019

9. Evaluation

Type of activity	9.1 Evaluation criteria	9.2 Evaluation methods.	9.3 Percentage in the final grade
9.4. Course	Verification of the theoretical knowledge	Written exam at the end of the semester	80%
9.5. Seminar/ laboratory	Verification of the practical knowledge	Written exam at the end of the semester	10%

	Evaluation of the presentations	Evaluation of the presentations during the seminary sessions.	10%
9.6 Minimum standard for passing			
• Cognition of the basic concepts and principles, the minimal note is 5.			

10. SDG labels (Sustainable Development Goals)

	○	Sustainable Development Generic Label						
								
○	○	○	X	X	○	○	○	○
								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
14 Aprilie 2026

Signature of course coordinator

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Signature of seminar coordinator

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Date of approval in the department:
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Signature of the head of department

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