

COURSE SYLLABUS

Course title: BIOMARKERS IN PRECISION MEDICINE

Course instructor: Dr. Anca Botezatu, CS I

Academic year: 2026-2027

Hours / week	Form of assessment	Credits
2	Examination	15

A. COURSE OBJECTIVES

General objective	Acquisition of advanced theoretical and practical knowledge regarding the molecular and genetic mechanisms underlying biomarker identification, as well as the use of molecular biology techniques for the implementation of precision medicine.
Specific objectives	• Description of the fundamental concepts and notions related to the structure, typology, and dynamics of biomarkers at the molecular level (genetic, epigenetic, transcriptomic, and proteomic alterations). • Understanding the technological and methodological principles of advanced molecular biology techniques (qPCR, digital PCR, Next-Generation Sequencing, ctDNA analysis) used for biomarker identification and quantification. • Correlation of molecular alterations and perturbed signaling pathways with the pathogenesis of diseases of major relevance to precision medicine (oncology, rare diseases, cardiogenetics) for accurate patient stratification. • Description of the molecular mechanisms of action of targeted therapies, mechanisms underlying the development of secondary resistance, and pharmacogenomic principles that determine the individual response to treatment. • Assessment of the analytical validity of molecular tests and interpretation of genetic variants according to international guidelines, with a view to establishing a molecular diagnostic algorithm and real-time monitoring of disease progression.

B. COURSE DELIVERY CONDITIONS (where applicable)

Course delivery	• Multimedia projector, video projector, laptop • Molecular biology, cell culture, proteomics, and flow cytometry laboratories.
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C. SPECIFIC COMPETENCIES ACQUIRED (Refers to the competencies provided by the study program to which the course belongs)

Professional competencies	• Identification and application of fundamental molecular biology concepts: Ability to accurately describe the structure, typology (genetic, epigenetic, transcriptomic, proteomic), and dynamics of biomarkers at the molecular level in physiological and pathological states. • Use and selection of advanced molecular diagnostic technologies: Ability to critically select and understand the operating principles of high-resolution techniques (qPCR, ddPCR, NGS, liquid biopsy) adapted to each type of biomarker analyzed. • Molecular patient stratification and pathogenic correlation: Ability to associate genetic alterations and perturbations of cellular signaling pathways with the pathogenesis of complex diseases (oncological, rare, cardiovascular) in order to classify patients into distinct prognostic and therapeutic subgroups. • Treatment personalization based on pharmacogenomic profiles: Ability to assess the molecular mechanisms of action of targeted therapies, anticipate the development of secondary resistance, and interpret genetic variants that influence drug metabolism. • Analytical validation and clinical interpretation of genetic variants: Competence to apply quality-control criteria in the molecular laboratory and classify identified variants according to international guidelines (ACMG/AMP, AMP/ASCO/CAP), in order to establish diagnostic and monitoring algorithms (e.g., MRD).
Transversal competencies	• Autonomy and responsibility in performing laboratory tasks: Execution of complex professional tasks under assisted autonomy, with strict compliance with biosafety standards, medical ethics, confidentiality of genetic data, and good laboratory practice. • Multidisciplinary teamwork: Development of interpersonal communication skills and effective collaboration within multidisciplinary medical or research teams, assuming coordination or execution roles in the clinical decision-making process. • Continuing professional development and critical thinking: Effective use of information resources and international bioinformatics databases for documentation, continuing education, and rapid adaptation to the dynamics of new discoveries and technologies in precision medicine.

D. COURSE CONTENT – LECTURES

No.	Chapter	Content	No. of hours
1	Introduction	Precision medicine: concepts, principles, and the role of biomarkers	2
2	Molecular Architecture and Types of Biomarkers	Types and characteristics of biomarkers: diagnostic, prognostic, predictive, and monitoring biomarkers	2

3	Genetic and Genomic Biomarkers	Genetic biomarkers: variants, polymorphisms, mutations, and their clinical significance	2
4	Epigenetic Modifications and Epigenetic Biomarkers	Epigenetic biomarkers: DNA methylation, histone modifications, and non-coding RNA	2
5	Transcriptomic and Proteomic Biomarkers	Expression biomarkers and multi-omics approaches: genome, epigenome, transcriptome, proteome, and metabolome	2
6	Molecular Biology Technologies and Methodologies	Molecular technologies for biomarker identification: PCR/qPCR, genotyping, and sequencing	2
7	Next-Generation Sequencing (NGS)	NGS and bioinformatics in biomarker discovery and characterization	4
8.	Biomarkers in Oncology	Identification of molecular biomarkers in cancer. Tumor heterogeneity, genetic and epigenetic alterations, biomarkers for diagnosis, prognosis, and therapeutic response. Examples from cervical cancer and pancreatic adenocarcinoma, myeloproliferative neoplasms, etc.	4
9.	Biomarkers of the Virus–Host Interaction	Biomarkers in infections and virus–host interactions: HPV, virome, microbiome, and response to infection	4
10.	Biomarkers in Reproductive Medicine	Couple infertility and integration of genetic, epigenetic, microbiota and clinical parameters	2
11	Clinical Validation, Regulations, and Bioethics	Clinical validation and translation of biomarkers. Patient stratification, diagnostic/prognostic algorithms, and perspectives of artificial intelligence	4
		Total	30

E. ASSESSMENT (The methods, forms of assessment, and their weighting in determining the final grade are specified. Minimum performance standards, related to the competencies defined under Section A. Course Objectives)

Activity type	Assessment criteria	Assessment methods	Weight in final grade
Participation in activities	Active participation, ability to provide arguments and integrate concepts	Observation of activity / discussions	20%
Analysis of an article/case study	Identification of the biomarker, biological and clinical relevance, critical analysis of methodology and results	Presentation / written analysis	30%
Final assessment	Correctness and coherence of answers; application of concepts to a biomedical case	Oral or written assessment	50%

The course assessment results are expressed using the following grades: “Very Good”; “Good”; “Satisfactory”; “Unsatisfactory”. The grades “Very Good”, “Good”, and “Satisfactory” allow the doctoral student to obtain the credits.

F. METHODOLOGICAL GUIDELINES

Lecture combined with dialogue. Use of modern teaching methods. Course materials.

G. CORRELATION OF COURSE CONTENT WITH THE EXPECTATIONS OF THE ACADEMIC COMMUNITY, PROFESSIONAL ASSOCIATIONS, AND REPRESENTATIVE EMPLOYERS IN THE FIELD RELEVANT TO THE PROGRAM

- The course provides a broad foundation of fundamental and practical knowledge concerning the identification, characterization, and use of genetic, epigenetic, and molecular biomarkers in precision medicine.
- The course provides basic knowledge of modern molecular investigation methods and the analysis of genomic and epigenomic data, useful to doctoral students in carrying out and interpreting the experimental component of their research.
- The acquired knowledge and competencies are relevant to biomedical research, molecular diagnostics, and the development of personalized approaches to diagnosis, prognosis, and monitoring of treatment response.

H. BIBLIOGRAPHY

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Course Instructor

Director of the Doctoral School

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