

Master's Degree in Dentistry and Dental Prosthetics 2023/2024

Integrated Teaching: Molecular biology and clinical pathology

Scientific Disciplinary Sectors: BIO/11; BIO/12; MED/05

Responsible Professor: Prof. [Luisa Pieroni](#); e-mail: luisa.pieroni@unicamillus.org

Number of University Educational Credits (CFU): 6

Module: Molecular biology

Scientific Disciplinary Sector: BIO/11

Number of University Educational Credits (CFU): 2

Professor: Prof. [Emiliano Maiani](#); e-mail: emiliano.maiani@unicamillus.org

Module: Clinical molecular biology

Scientific Disciplinary Sector: BIO/12

Number of University Educational Credits (CFU): 2

Professor: Prof.ssa [Luisa Pieroni](#); e-mail: luisa.pieroni@unicamillus.org

Module: Clinical pathology

Scientific Disciplinary Sector: MED/05

Number of University Educational Credits (CFU): 2

Professor: Prof. [Silvia Consalvi](#); e-mail: silvia.consalvi@unicamillus.org

PREREQUISITES

Although there is no prerequisite, for a correct understanding of the notions of this integrated teaching. Students must be aware of fundamental concepts acquired in the Biology and Genetics, Biochemistry and Human Anatomy teachings

LEARNING OBJECTIVES

The integrated teaching of Molecular Biology and Clinical Pathology will provide the student with the fundamentals of Molecular Biology and Pathology and will allow the student to translate the basic knowledge acquired into clinical diagnostic applications. The main methodologies used in molecular, biochemical, and cellular diagnostics will be presented, and the conceptual approaches according to which they have been developed will be explained.

Different types of tests based on the determination of DNA, RNA, proteins, or metabolites will be introduced and discussed to identify specific pathophysiological states and the main disease markers that measurable in a clinical laboratory will be studied.

At the end of the course the student will have acquired the basic elements in the clinical diagnosis of the main pathologies, will be able to use laboratory procedures by applying the experimental method, analyze and correctly interpret experimental data both in the healthcare field and in research and cooperate in clinical reasoning.

LEARNING OUTCOMES

The learning outcomes expected from the integrated teaching Molecular Biology and Clinical Pathology are consistent with the provisions from the Bologna Process and are found within the Dublin descriptors as follows:

Knowledge and understanding

At the end of this teaching, the student will acquire:

- Knowledge of the molecular basis of biological processes of eucaryotic cells and microorganisms.
- Knowledge of the molecular regulation mechanisms of genome replication and expression
- Knowledge of the structure and function of nucleic acids and proteins
- Knowledge of the fundamental molecular techniques and applications for diagnostic and study purpose
- Knowledge of specific diagnostic test, and interval references
- Knowledge of appropriate test for specific pathology

Applying knowledge and understanding

At the end of this teaching, the student will be able to:

- Understand the molecular basis of human diseases
- Understand medical approaches to molecular medicine and translational research.
- Understand application of molecular techniques for diagnostic and research purpose
- Understand test significance (reference values) and proper application in specific pathological conditions.
- Apply proper test to develop a diagnostic hypothesis, define prognosis and plan a therapeutic intervention
- Apply the acquired knowledge in the specific field of the professional activity
- Develop teamwork skills to make diagnosis, to choose therapeutic strategies and to follow up patient, to obtain the best possible clinical and cost effective result

Communication skills

At the end of this teaching, the student will be expected to communicate scientific contents in a clear and unambiguous way, using appropriate technical language

Making judgements

At the end of this teaching, the student will be able to:

- Carry out assessments of the topics covered.
- Autonomously interpret the data pertaining the topics covered by the course

Learning skills

At the end of the course the student must be able to deepen and keep their knowledge and skills up-to-date by consulting scientific literature, databases and specialist websites, grasping the fundamental and relevant aspects for their professional context.

COURSE SYLLABUS

Molecular Biology

- Structure of DNA and RNA,
- Chemical-physical properties of nucleic acids and nucleotides.
- Topological properties of DNA.
- Supercoiling of DNA, euchromatin and heterochromatin,
- Structure of chromatin, histones, nucleosomes.
- Epigenetic modifications of histone tails and chromatin conformation, histone acetylase and deacetylase. DNA and histone methylation.
- Genomic structure in eukaryotes. Genome and exome. DNA replication.
- Semiconservative and bidirectional synthesis of DNA.
- Mechanism of action of DNA polymerases.
- Correction of errors during polymerization. Duplication of leading and lagging strands, Okazaki fragments.
- Enzymes and proteins involved in DNA replication. Telomeres and telomerase.
- Transcription, promoter of RNA pol II in eukaryotes.
- Basal and specific/regulatory transcription factors.
- Promoter, enhancer, silencer. Assembly of transcription complexes and role of transcription factors.
- Regulation of transcription in prokaryotes and eukaryotes.
- Exons and introns. Maturation of eukaryotic rRNA, siRNA and miRNA.
- mRNA maturation: capping, polyadenylation, splicing.
- The spliceosome complex. RNA interference and MicroRNAs. Long non-coding RNA.
- The genetic code: codons, universality, degeneration and synonymous codons, reading phase.
- Protein synthesis (translation). Activation of amino acids, aminoacyl synthetase.
- Initiation, elongation and termination of translation in prokaryotes and eukaryotes, with initiation, elongation and termination factors.
- Primary, secondary and tertiary structure of proteins.
- Intrinsically disordered proteins.
- Electrophoretic techniques, SDS-PAGE, Northern Blot and Western Blot,
- Acrylamide and agarose gel.

Clinical Molecular Biology

- Introduction to Clinical Molecular Biology: molecular medicine and molecular diagnostics, appropriateness of laboratory medicine and diagnostic process
- Organization of the diagnostic laboratory: sectors of the laboratory, use of the laboratory, interpretation of results, sources of variability, types and collection of the clinical sample
- Molecular biomarkers: characteristics, definition and interpretation of molecular biomarkers.
- Analytical techniques to discriminate, identify and amplify nucleic acids and examples of clinical application: agarose gel electrophoresis, PCR, gene sequencing (Sanger method), hybridization (southern blot, northern blot, in situ hybridization, etc..), recombinant DNA and microarray.
- Electrophoretic techniques for protein analysis: SDS-PAGE, 2D Electrophoresis, Western

Blot

- Genome editing and gene therapy concept: Development and application of the CRISPR/Cas9 technique, Viral Vectors and Gene Therapy
- Introduction to omics science and holistic approach, concepts of Genome, Transcriptome and Proteome
- Human Genome Project and genome annotations
- Next Generation Sequencing and clinical applications of gene sequencing
- Transcriptomics, RNA sequencing and clinical applications
- Proteome analysis and clinical applications

Clinical Pathology

- Introduction to clinical pathology and evaluation of laboratory tests
- Complete blood count and related disorders
- The laboratory in the evaluation of the haemostatic function
- Outline of transfusion medicine
- Inflammation biomarkers
- Principles of the immunological diagnosis of autoimmune diseases.
- Biochemical indicators of liver function and damage, jaundice
- Parameters of function and renal damage
- The laboratory in the diagnostic evaluation of diabetes
- Laboratory diagnosis of dyslipoproteinemias

COURSE STRUCTURE

The course is structured in 60 hours of frontal teaching (20 hours Molecular Biology, 20 hours Clinical Molecular Biology, 20 hours Clinical Pathology). Lectures will include theoretical lessons on the topics of the program, interactive discussion and cooperative learning. Teaching tools such as presentations organized in powerpoint files with explanatory diagrams, illustrations and images will be used

COURSE GRADE DETERMINATION

The exam is unique for the entire integrated course, it is not possible to take exam tests for the individual modules.

The exam consists of a written test comprising 12 questions with multiple choice answers for each single teaching for a total of 36 questions. The score associated with the correct answer will be indicated on the test. No penalty will be assigned to unanswered questions or incorrect answers. Students will have 40 minutes to complete the test. The exam will be passed with a minimum score of 18/30. The score obtained, even if sufficient, will not be considered valid for passing the test if the student has not answered correctly the questions relating to even one course: at least 50% of the answers of each course must be correct to pass the exam. The final exam grade will be calculated according to the following criteria:

Not suitable: Poor or lacking knowledge and understanding of the topics; limited capacity for analysis and synthesis, frequent generalizations of the requested contents; inability to use technical language.

18-20: Just sufficient knowledge and understanding of the topics, with obvious imperfections; just sufficient capacity for analysis, synthesis and autonomy of judgment; poor ability to use technical language.

21-23: Sufficient knowledge and understanding of the topics; sufficient ability to analyze and synthesize with the ability to reason with logic and coherence the required contents; sufficient ability to use technical language.

24-26: Fair knowledge and understanding of the topics; discrete ability to analyze and synthesize with the ability to rigorously argue the required contents; good ability to use technical language

27-29: Good knowledge and understanding of the required contents; good ability to analyze and synthesize with the ability to rigorously argue the required contents; good ability to use technical language.

30-30L: Excellent level of knowledge and understanding of the required contents with an excellent ability to analyze and synthesize with the ability to argue the required contents in a rigorous, innovative and original way; excellent ability to use technical language

OPTIONAL ACTIVITIES

In addition to the frontal teaching activity, students can be received by individual teachers by requesting an appointment via email.

READING MATERIALS

Molecular Biology

- Bruce Alberts et al., *Molecular Biology of the Cell*, VII ed., WW Norton & Co.
Alternatively:
- Michael M. Cox, Jennifer Doudna, Michael O'Donnell. *Biologia Molecolare. Principi e tecniche*, Zanichelli 2013
- Teaching material provided by the teacher during the lessons

Clinical Molecular Biology

- Bruce Alberts et al., *Molecular Biology of the Cell*, VII ed., WW Norton & Co.
Alternatively:
- Michael M. Cox, Jennifer Doudna, Michael O'Donnell. *Biologia Molecolare. Principi e tecniche*, Zanichelli 2013
- Teaching material provided by the teacher during the lessons

Clinical Pathology

- Laposata's *Laboratory Medicine Diagnosis of Disease in Clinical Laboratory 3rd Edition* – LANGEC – Mc Graw Hill 2018

Teaching material provided by the teacher during the lessons