FACULTY OF STOMATOLOGY

STUDY PROGRAM 0911.1 STOMATOLOGY

CHAIR OF MOLECULAR BIOLOGY AND HUMAN GENETICS

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum in Stomatology
Minutes No. 2 of 30.01.2025
Chairman, PhD, DMS, Associate professor,
Zanoaga Oleg _____

APPROVED
at the Council meeting of the Faculty of Stomatology
Minutes No. 4 of 04.02.2025
Dean of Faculty, PhD, Associate Professor,
Solomon Oleg _____

APPROVED
approved at the meeting of the chair of Molecular Biology and Human
Minutes No.10 of 13.01.2025
Head of chair, Associate professor, PhD
Cemortan Igor _____

SYLLABUS

DISCIPLINE **MOLECULAR BIOLOGY**

Integrated studies

Type of course: **Compulsory discipline**

Curriculum developed by the team of authors:

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Chisinau, 2025

I. INTRODUCTION

- **General presentation of the discipline: place and role of the discipline in the formation of the specific competences of the professional / specialty training program**

The course of molecular biology is an important part of preclinical education, and its main objective is to study the molecular structure of the cell - the basic structural, biochemical, functional level of the human body.

The content of the course is structured to demonstrate that living organisms, regardless of their complexity, including the human organism, have a common organizational principle, which determines them to be self-reproducing, self-renewing and self-regulating systems; the peculiarities of an organism structure and functions are encoded in DNA molecules and expressed through the synthesis of RNA molecules and proteins, which are the molecular substrate of all structures, properties and functions of the human body; DNA replication, repair, encoding genetic information, transcription and translation - fundamental processes that explain vitality; the dynamics of cellular components and molecular processes depending on cell cycle period, cell type and ontogenetic period of the body - the basis of human body development, cell differentiation and transformation.

- **Mission of the curriculum (aim) in professional training**

One of the main objectives of the course is to demonstrate the link between the structure and function of biopolymers, cell compartments, different cell types. The second objective is to evaluate the relationship in the chain: the function of a cellular component at the molecular →cellular → organism level. The third objective is to understand the medical role of DNA, RNA and proteins. It is important that any pathological process can be based on cellular changes: metabolic defects; structural defects; signaling defects; defects in cellular contacts; etc.

Knowing the organization and functioning of the cell / cells provides the student of Faculty of Stomatology the chance to understand the mechanisms of human disease production and ways of solving pathological processes. 21st Century Medicine is MOLECULAR MEDICINE.

- **Language (s) of the discipline**: Romanian, Russian and English.

- **Beneficiaries:** students of the 1st year, Faculty of Stomatology.

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		F.01.O.003	
Name of the discipline		**Molecular Biology**	
Person(s) in charge of the discipline		Associate professor, PhD **Igor Cemortan**	
Year	**I**	Semester/Semesters	**1**
Total number of hours, including:			**120**
Lectures	**30**	Practical/laboratory hours	**15**
Seminars	**15**	Self-training	**60**
Form of assessment	**E**	Number of credits	**4**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study the student will be able to:

at the level of knowledge and understanding:

- know the peculiarities of organization of biological systems;
- know the fundamental properties of life and its molecular organization;
- understand the principles of human cell compartmentalization, the characteristic features of each compartment, the set of characteristic molecules and the interrelationships between different cell organelles and the cells of a multicellular organism;
- know the relationship DNA-RNA-protein --- cellular structures and functions and their effects at the body level; to know the relationship Genome → Transcriptome → Proteome → Metabolome → Phenome;
- understand how the human genome is organized, the particularities of the storage, transmission and realization of genetic information at the molecular, cellular and body level;
- know the principles of basic molecular processes: transcription, translation, replication and repair;
- know the particularities of organization and functioning of the human cell vs. the bacterial cell;
- understand the basic processes that ensure the growth of the multicellular organism, cell differentiation, renewal and regeneration of tissues - mitosis and apoptosis.
- understand the basis of diversity of living organisms, intra- and inter-familial variability of the human organism – intra-chromosomal, inter-chromosomal and genomic recombination;
- know the basics of DNA technology, the principles of human gene study techniques.

at the application level:

- distinguish cellular forms of life from acellular;
- distinguish the eukaryotic from the prokaryotic cell;
- model basic genetic processes: replication, transcription, translation;
- evaluate the practical role of recombinant DNA technology;
- distinguish separation of DNA and mRNA from human cells;
- interpret the results obtained by different DNA sequencing methods;
- interpret the results obtained by the PCR technique;
- interpret the results obtained by the Southern blot technique;
- read out the results of electrophoresis of DNA fragments obtained by various techniques.

at the integration level:

- assess the place and role of molecular biology in the pre-clinical training of the medical student;
- use the knowledge and methodology of molecular biology to explain the nature of physiological or pathological processes;
- make the link between structure and function at molecular level → at cellular level → at tissue level → at organism level;
- deduce the possible causes of blocking the basic molecular processes and the consequences on the cell, tissue, organism as a whole;
- implement the knowledge gained in the research activity;
- use critically and with confidence the scientific information obtained using the new information and communication technologies;
- use multimedia technology to receive, evaluate, store, produce, present and exchange information, and communicate and participate in networks via the Internet;
- learn to learn, which will contribute to the management of the professional development.

IV. PROVISIONAL TERMS AND CONDITIONS

Requirements for first year students:
• knowledge of the language of studies;
• confirmed competences in sciences (biology, chemistry, physics) at the school level;
• digital competences (use of the Internet, document processing, electronic tables and presentations, use of graphics programs);
• ability to communicate and work in a team;
• qualities - tolerance, compassion, autonomy.

V. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/ laboratory hours/seminars and self-training

No. d/o	THEME	Number of hours			
		Lectures	Practical hours	Seminars	Self-training
1.	Biological systems. Proprieties of biological systems. Levels of organization of biological systems. The cell as structural and functional unit of life. Acellular forms of life: viruses and prions. Comparative characterization of prokaryotic and eukaryotic cells. Main cell components: chemical organization and cell compartments. Cytosol and cytoskeleton.	2	1	1	4
2.	Macromolecules. Simple and complex proteins. Their location in the cell. Biological functions. Activation and inactivation of proteins. Carbohydrates. Functions of deposition and signaling. Lipids. Phospholipids. Cholesterol. Nucleic acids	2	1	1	4
3.	Nucleic acids – structure, properties, functions. Peculiarities of prokaryotic and eukaryotic DNA. Types of cellular RNAs their biogenesis and functions.	2	1	1	4
4.	Biological membranes. Plasmalemma. Particularities of the internal cell membranes and their biogenesis. Transmembrane transport. Cell junctions.	2	1	1	4
5.	Compartmentalization of eukaryotic cells. Cell organelles: structure, main functions. Biogenesis of membranes. Biological role of endocytosis and exocytosis. Cytoskeleton. Peculiarities of osteoblasts and ameloblasts organization.	2	1	1	4
6.	Organization of nuclear genetic material. Organization of coding and non-coding DNA segments in the human cell nucleus. The way of presentation of the nuclear genetic material depending on the period of cell cycle, transcriptional activity, age, cell type. The nucleolus. Biogenesis of ribosomes.	2	2	1	4
7.	Structure and functions of prokaryotic and eukaryotic genes. Coding, non-coding, regulatory and modulatory sequences. Structure and functions of the 1^{st}, 2^{nd}, and 3^{rd} class genes. Peculiarities of mitochondrial genes organization. Peculiarities of genes responsible for amelogenesis.	2	1	1	4
8.	Gene expression. Transcription of genetic information. Characteristics of transcription apparatus. Peculiarities of transcription in prokaryotes and eukaryotes. Processing of RNA. Modeling of transcription, pre-mRNA processing and alternative splicing.	2	1	1	4
9.	Translation. Genetic code. Characteristics of translation apparatus.	2	1	1	4

No. d/o	THEME	Number of hours			
		Lectures	Practical hours	Seminars	Self-training
	Modelling of translation initiation, elongation and termination.				
10.	Modelling of the 1st, 2nd, and 3rd class gene expression. Control of gene expression. Evaluation of the possible causes of one gene transcription blocking, splicing defects, translation blocking.	2	1	1	4
11.	DNA replication. Characteristics of the replication apparatus in eukaryotes and prokaryotes. Replication models and the biological role of replication. DNA repair. Characteristics of different repair systems.	2	1	1	4
12.	Cell cycle. Interphase. Mitosis. Apoptosis. Dynamics of chromosomes in different periods of cell cycle. Renewing and regeneration of teeth.	2	1	1	4
13.	Meiosis. Molecular mechanisms. Biological importance of meiosis. Intra- and inter-chromosomal recombination. Dynamics of chromosomes in different periods of meiosis.	2	1	1	4
14.	Recombinant DNA technologies. Isolation of DNA. Selection of cloning vectors. Steps of *in vivo* cloning. *In vitro* DNA cloning and characteristics of the artificial replication apparatus.	2	1	1	4
15.	Methods of gene analysis. Application and limits of genetic engineering in stomatology.	2	1	1	4
Total		**30**	**15**	**15**	60

VI. REFERENCE OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Chapter 1. „Molecular organization of human cell”	
• To define biopolymers and cell compartments • to know the structure, properties and functions of biopolymers and their location in the cell • to demonstrate the principles of cell compartmentalization and the interaction between different compartments • to comment on the medical significance of biopolymers • to apply knowledge to other disciplines • to formulate conclusions • to develop own views on the biological and medical role of biopolymers and cell compartments	1. Cell as a structural, functional and pathological unit of human organism. 2. Nucleic acids as carriers of genetic information about organization and functions of cell. 3. Proteins – substrate of all structures, properties and functions at the level of cell, tissue, organism. 4. Interactions between macromolecules, determining the integrity of biological systems, the structural and functional quality of organisms.
Chapter 2. Main molecular processes	
• To define gene, gene expression, transcription, processing, splicing, alternative splicing, translation, genetic code, replicon, replication, NER repair; BER repair • To know the peculiarities of organization of different human vs. prokaryotes genes; the peculiarities of the expression of nuclear vs mitochondrial vs bacterial genes; • to know the principles and the apparatus of transcription, processing and translation; • to know the peculiarities of nuclear vs. mitochondrial vs. prokaryotic DNA replication; • to demonstrate the peculiarities of GI expression and the importance of this knowledge in eukaryotes vs. prokaryotes • to model the expression of Class I, Class II, Class III genes and prokaryotic genes • to model the translation of the genetic code • to apply the knowledge gained in other subjects	1. Structure and functions of genes. Coding, non-coding, regulatory and modulatory sequences. Mobile genetic elements. 2. Transcription of genetic material. Steps of transcription. Apparatus of transcription. Processing of RNA. RNA splicing. Alternative splicing and its biological importance. 3. Translation – polypeptide biosynthesis. Characteristics and properties of the genetic code. Stages and apparatus of translation. Regulation of gene expression in eukaryotes. Levels of regulation of gene activity. Regulation of gene activity in ontogenesis and cell specialization. 4. DNA replication. Apparatus of replication. Peculiarities of replication in prokaryotes and eukaryotes. Synthesis of telomeres. Replication of mitochondrial DNA. 5. DNA repair.
Chapter 3. Transmission of genetic information from cell to cell, from parents to offspring	
• To define interphase, mitosis, meiosis, gametogenesis, crossing-over, gametocyte, gamete, G0 period, somatic cell, STEM cell, apoptosis	1. Cell cycle. Interphase: sequence of main events. Restriction points. G_o period. Dynamics of chromosomes during mitosis. Control of cell cycle. Types of cell proliferation. Malign transformation.

Objectives	Content units
• to know the particularities of the cell cycle, the dynamics of the chromosomes in G1, S, G2, prophase, metaphase, anaphase, telophase; • to know the modality and particularities of the meiosis, the dynamics of the chromosomes during the reductional and equational divisions; • to know the particularities of apoptosis; • to understand the mechanisms of cell cycle control and cell transformation pathways; • to understand the particularities of the development of meiosis in oogenesis vs spermatogenesis; • to demonstrate the medical role of knowing the cell cycle, apoptosis;	2. Apoptosis programmed cell death. Mechanisms of apoptosis. Biological importance of apoptosis. Control of apoptosis. 3. Recombination. Meiosis: Crossing-over and its biological importance. Dynamics of chromosomes during meiosis. Peculiarities of gametogenesis in males and females.
Chapter 4. Basics of the genetic engineering	
• To define recombinant DNA, DNA cloning, in vivo cloning, in vitro cloning, restriction enzymes, molecular markers, synthetic primers, PCR • to know the principles, stages and components needed for recombinant DNA technology; • to know the particularities of cloning vectors and hosts; • to know the particularities of DNA cloning *in vitro*; • to understand the principles of genomic DNA and RNA isolation for different techniques; • to understand the principles of gene analysis techniques; • to model *in vivo* cloning and *in vitro* cloning of DNA • to model the PCR and the Southern-blot techniques • to interpret the results obtained by the PCR technique; • to interpret the results obtained by the Southern blot technique.	1. Recombinant DNA technology. Restriction enzymes. Restriction maps. Cloning vectors: plasmids and bacteriophages. 2. Isolation and purification of DNA and RNA. DNA and genomic libraries. 3. Principles of in vivo and in vitro gene cloning. 4. Methods of gene analysis. Gene sequencing. Southern, Northern and Western-blot analysis. PCR and its applications.

VII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY FINALITIES

✓ **Professional (specific) (CP) competences**

CP1. The responsible execution of professional tasks with the application of the values and norms of professional ethics, as well as the provisions of the legislation in force. Apply the legal and normative framework in practical activity. Respects the norms of ethics and deontology. It ensures compliance with ethical and deontological norms and is guided by the provisions of the code of medical ethics. Promote collegial relationships with co-workers. Carry out free and independent activities according to the oath of the medical profession. Knows and respects the rights and technical rules regarding the sanitary-hygienic and anti-epidemic regime in various socio-medical situations according to the legislation in force. Knows and respects the provisions of the collective labor agreement, the protection rules and the safety and health technique at the workplace. It ensures compliance and correctness of the fulfillment of service obligations in the provision of care to the population in public, private and community medical and sanitary institutions. It encourages informed ethical decision making and respects the patient's decision.

CP2. Adequate knowledge of the sciences about the structure of the body, the physiological functions and the behavior of the human body in various physiological and pathological states, as well as the existing relationships between the state of health, the physical and the social environment. Knows the structures, physiological functions of organs and organ systems in healthy subjects. Recognizes the physiological and pathological processes of the human being and the psychosocial responses of individuals in various states of health. Knows the relevant terminology for the important signs and symptoms that are derived from various pathophysiological conditions. Identifies pathophysiological processes and their expression, as well as risk factors that determine health and disease at different stages of the life cycle. Appreciate the relationship between the state of health, the physical and social environment of the human being. Knows the possible evolution and complications leading to the main pathological processes.

CP3. Conducting scientific research in the field of health and other branches of science. Plans, organizes and executes scientific research in the field. Identifies sources of information, selects research materials and methods, performs experiments, statistical processing of research results, formulation of conclusions and proposals. Elaborates and supports speeches, presentations at scientific events by demonstrating personal attitude, coherence in exposition and scientific correctness; participates in discussions and debates at scientific events.

CP4. Promoting and ensuring the prestige of the medical profession and raising the professional level. Plan, organize and execute scientific research in the field. Identifies sources of information, selects research materials and methods, performs experiments, statistical processing of research results, formulation of conclusions and proposals. Elaborates and supports speeches, presentations at scientific events by demonstrating personal attitude, coherence in exposition and scientific correctness; participates in discussions and debates at scientific events. It achieves the maintenance of the high level of professional skills during the entire period of activity. Actively participates in professional associations for the purpose of correctly fulfilling professional obligations, promoting the image of the doctor and the medical system in society. It contributes to the adjustment of the legislative framework in the field of medical assistance to European standards, ensuring the quality of the medical act, implementing the Rules of Good Practice, promoting the image of the medical profession at scientific-practical events and in the mass media.

✓ **Transversal competences (CT)**

CT1. Autonomy and responsibility in activity. The application of rigorous and efficient work rules, the manifestation of a responsible attitude towards the performance of professional tasks with the application of the values and norms of professional ethics, as well as the provisions of the legislation in force. Promoting

logical reasoning, practical applicability, evaluation and self-evaluation in decision-making.

✓ **Study finalities**

- To know the organizational features, fundamental properties of life and the molecular basis of biological systems;
- To understand the principles of human cell compartmentalization;
- To understand the relationship Genome → Transcriptome → Proteinome → Metabolome → Phenome;
- To know the principles and model the basic molecular processes: transcription, translation, replication and repair;
- To know the particularities of organization and functioning of the human cell vs. the bacterial cell;
- To understand the basic processes that ensure the growth of the multicellular organism, cell differentiation, renewal and regeneration of tissues - mitosis and apoptosis.
- To know the bases and the practical role of recombinant DNA technology, the principles of human gene study techniques.
- To be able to assess the place and role of molecular biology in the pre-clinical training of the student of Faculty of Stomatology;
- To be competent to use the knowledge and methodology of molecular biology to explain the nature of physiological or pathological processes;
- To be able to deduce the possible causes of blocking the underlying molecular processes and their consequences on the cell, the tissue, the body as a whole;
- To be able to implement the knowledge gained in the research activity;
- To be competent to use critically and with confidence the scientific information obtained using the new information and communication technologies.

VIII. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with information sources:	Reading the lecture or the material from the textbook on the topic carefully. Reading questions on the topic, which require a reflection on the subject. To get acquainted with the list of additional information sources on the topic. Select the source of additional information for the topic. Reading the text entirely, carefully and writing the main content. Writing generalizations and conclusions regarding the importance of the topic / subject.	Ability to extract the main information; interpretative skills; the volume of work	During the semester
2.	Working with the Workbook:	Before solving the tasks in the workbook to analyze the information and images from the respective subject in the lecture and textbook. Solving consecutive tasks. Formulate conclusions at the end of each lesson. Verifying the final conclusions of the lesson and appreciating their fulfilment. Selection of additional information, using electronic addresses and additional bibliography.	Workload, problem solving, ability to formulate conclusions	During the semester
3.	Working with online materials	Online self-assessment, study of online materials on the Chair site, expressing own opinions on forum and chat	Number and duration of chair site entries, self-evaluation results	During the semester

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

- ***Teaching and learning methods used***

  In teaching Molecular Biology are used various didactic methods and techniques, oriented towards the efficient learning and achievement of the objectives of the didactic process. During theoretical lectures, along with traditional methods (lecture-exposure, lecture-conversation, synthesis lecture), modern methods (lesson-debate, lecture-conference, problem-lesson) are also used. Forms of individual, frontal, group, virtual lab work are used in the practical classes. To learn the material in depth, different semiotic systems (scientific language, graphical and computerized language) and teaching materials (tables, diagrams, micro-pictures, transparent films) are used. During the lessons and extracurricular activities are used Communication Information Technologies - PowerPoint presentations, on-line lessons.

Recommended learning methods

- **Observation** - Identification of elements characteristic to some structures or biological phenomena, describing these elements or phenomena.
- **Analysis** - Imaginary decomposition of the whole into component parts. Highlighting the essential elements. Studying each element as part of the whole.
- **Diagram / picture analysis** - Selection of required information. Recognition based on knowledge and selected information of the structures indicated in the diagram, drawing. Analysis of the functions / role of recognized structures.
- **Comparison** - Analysis of the first object / process in a group and determining its main features. Analysis of the second object / process and determining its main features. Comparing objects / processes and highlighting common features. Comparing objects / processes and determining differences. Establishing distinguishing criteria. Formulating conclusions.
- **Classification** - Identification of the structures / processes to be classified. Determining the criteria on which classification is to be made. Distribution of structures / processes by groups according to established criteria.
- **Scheme drawing** - Selection of elements, which must be included in the scheme. Showing the selected elements through different symbols / colors and showing their relationships. Formulating an appropriate title and legend for the symbols used.
- **Modeling** - Identifying and selecting the elements needed for modeling the phenomenon. Imaging (graphically, schematically) the phenomenon studied. Realizing the phenomenon using the developed model. Formulating conclusions, deduced from arguments or findings.
- **Experiment** - Formulating a hypothesis, based on known facts, on the process / phenomenon studied. Verifying the hypothesis by performing the processes / phenomena studied under laboratory conditions. Formulation of conclusions deduced from arguments or findings.

- ***Applied teaching strategies / technologies*** *(specific to the discipline)*

  "Brainstorming", "Multi-voting"; "The round table"; "Group Interview"; "Case Study"; "Creative Controversy"; "Focus-group technique", "Portfolio".
  Virtual Practices

- ***Methods of assessment*** *(including the method of final mark calculation)*

✓ **Current**: frontal and / or individual control through

- (a) applying docimological tests,
- (b) solving problems / exercises,

- (c) analysis of case studies
- (d) performing role-plays on the topics discussed.
- (e) tests

Final: exam

The **final mark** will consist of the average mark of three concluding tests (50%), and the final test in computerized system (50%).

The average mark and the marks of all the final exam stages (computer, written test) - will be expressed in numbers according to the marks scale (as in the table) and the final mark obtained will be expressed in two decimals and will be written in the marks book.

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-9,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations.

X. RECOMMENDED LITERATURE:

A. Compulsory:

1. Molecular biology. Exercise book Capcelea S., Perciuleac L., Cemortan I, 2024
2. Presentations of lectures: SIMU
3. Reading materials: www.biologiemoleculară.usmf.md
4. On line-tests: e.usmf. md

B. Additional

1. https://ghr.nlm.nih.gov/
2. http://www.genecards.org/
3. https://www.malacards.org/
4. https://www.ncbi.nlm.nih.gov/pubmed/
5. https://genome.cshlp.org/
6. Cell biology. Pollard Th., Earnshaw W., 2017
7. Molecular Biology of the Cell. B. Alberts 2016
8. Genes. B. Lewin, 2017