COURSE UNIT DESCRIPTION - MOLECULAR BIOLOGY I

Course unit title	Code
MOLECULAR BIOLOGY I	

Lecturer(s)	Department(s)
Coordinator: Prof. Edita SUŽIEDĖLIENĖ Other(s): Dr. Julija Armalytė Lect. dr. Violeta Jonušienė Dr. Danutė Labeikytė Lect. dr. Aušra Sasnauskienė	Vilnius University, Department of Biochemistry and Molecular Biology, M.K.Čiurlionio g. 21/27, LT-03101 Vilnius

Cycle	Level of the course unit	Type of the course unit
Full-time studies (1st stage)	1 out of 2	Compulsory

Mode of delivery	Period of delivered	Language(s) of instruction
Face to face	4th semester, spring	Lithuanian (English)

Prerequisites and corequisities	
Prerequisites: Biochemistry, organic chemistry	**Corequisities (if any):**

Number of credits allocated to the course unit	Student's total workload	Contact hours		Self-study and research hours
5	**150**	Lectures	**32**	**70**
		Seminars	**16**	
		Laboratory works	**32**	

Purpose of the course unit: programme competences to be developed

Upon the successful completion of this course, students will acquire:

Subject-specific competences:

- the modern life sciences research-based knowledge of the fundamental molecular processes of the storage, multiplication, transfer and realization of biological information in the prokaryotic and eukaryotic cell;
- the knowledge of the structure and functions of essential biological macromolecules;
- skills to analytically, critically and systemically analyze and evaluate information in molecular biology and related scientific fields;
- skills to carry out basic molecular biology laboratory procedures, work with standard molecular biology and biomedical equipment; perform reliable measurements, document and analyse the results of the measurements;
- skills to select appropriate molecular biology methods for the investigation of biological molecules; perform experiments, interpret the data obtained and draw science-based conclusions.

General competences:

- skills for self-development, skills to study molecular biology and general science resourses;
- skills to present in written and verbal forms the knowledge and concepts of molecular biology;
- skills to participate in the scientific discussion;
- skills to organize and plan work and time.

Learning outcomes of the course unit	Teaching and learning methods	Assessment methods
• Describes principles of DNA, RNA, protein molecular structure and their functional role in	Lectures, seminars laboratory work; self-study.	Midterm exam; defence of Lab

cellular processes; • Analyses, compares and critically evaluates the molecular biology information related to DNA, RNA protein molecular structure and functions; • Selects and applies methods of DNA isolation and analysis; performs experiments, interprets the data, presents research-based conclusions;		Report; written analysis of scientific paper.
• Describes principles of molecular chromatin structure and its dynamics; • Analyses, compares and critically evaluates the molecular biology information related to chromatin molecular structure and functions;	Lectures, seminars; self-study.	Midterm exam; written analysis of scientific paper.
• Describes principles of DNA biosynthesis in prokaryotes and eukaryotes and its regulation, the structure, function and differences of replication machineries; • Analyses, compares and critically evaluates the molecular biology information related to DNA biosynthesis; • Selects and applies PCR method and its modifications for DNA analysis; performs experiments, interprets the data, presents research-based conclusions.	Lectures, seminars; laboratory work; self-study.	Final exam; defence of Lab Report; written analysis of scientific paper.
• Describes molecular principles of RNA biosynthesis in prokaryotes and eukaryotes and molecular structure of transcription machineries; • Describes principles of transcription regulation in prokaryotes and eukaryotes, basic features of *trans*- and *cis*-acting transcriptional regulators; • Analyses, compares and critically evaluates the molecular biology information related to RNA biosynthesis and its regulation; • Selects and applies methods for RNA isolation and analysis; performs experiments, interprets the data, presents research-based conclusions.	Lectures, seminars; laboratory work; self-study.	Final exam; defence of Lab Report; written analysis of scientific paper.

Content: breakdown of the topics	**Contact hours**							**Self-study work: time and assignments**	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. DNA, RNA and Protein Structure	**9**		**5**				**14**	**12**	Self-directed learning of the topic-related textbook material (course virtual learning environment); Reading of the topic-related scientific papers and preparation for written analysis **1** of scientific paper.
DNA molecular structure. DNA primary structure**.** DNA secondary structure. DNA A, B, Z and other family helixes. Unusual DNA secondary structures.	2		1				**3**	3	The same
DNA supercoiling. Topoisomerases. DNA tertiary structure. Circular DNA and supercoiling. Structure	2		1				**3**	3	The same

and functions of topoisomerases.									
RNA molecular structure. tRNA secondary and tertiary structure. rRNA secondary and tertiary structure. Ribozymes. Riboswitches. Small cellular RNAs.	3		2				**5**	3	The same
Protein molecular structure. Protein primary, secondary, tertiary and quaternary structures. Protein folding and missfolding.	2		1				**3**	3	The same
2. Chromatin Molecular Structure	**5**		3				**8**	**10**	Self-directed learning of the topic-related textbook material (course virtual learning environment), Reading of the topic-related scientific papers and preparation for written analysis **2** of scientific paper.
Molecular structure of the nucleosome. Nucleosome core. Histones: structure and features. Histone modifications and their biological role. Histone code.	1		1				**2**	2	The same
Chromatin higher level molecular structures.10 nm and 30 nm chromatin fibres.	2		1				**3**	4	The same
Chromatin, replication and transcription. Chromatin and replication. Chromatin and transcription and its regulation. Histone modifications and transcription regulation. Chromatin remodelling protein complexes and transcription regulation. DNA organisation in prokaryotes. Bacterial nucleoid.	2		1				**3**	4	The same
3. DNA Biosynthesis	**9**		4				**13**	**12**	Self-directed learning of the topic-related textbook material (course virtual learning environment), Reading of the topic-related scientific papers and preparation for written analysis **3** of scientific paper.
DNA Polymerases. Structure and mechanism of catalysis. Replication fidelity. Diversity of DNA polymerases.	2		1				**3**	**3**	The same
Replication in prokaryotes. Bacterial DNA Polymerases I-V. DNA polymerase III holoenzyme and functions of its subunits. Assembly of DNA pol III holoenzyme. Binding of sliding clamp and core DNA pol III to DNA. Structure of replication fork. Bacterial replicative primase. Bacterial replicative DNA helicase. SSB proteins. Initiation of replication in bacteria. Replisome	3		1				**4**	**4**	The same

assembly at *ori* site. Replication elongation. Okazaki fragments, their synthesis and maturation of the lagging strand. DNA ligases. Replication termination. Bacterial replicons.									
Replication in eukaryotes. Structure and features of eukaryotic replication fork. DNA polymerase alpha/primase. Replication protein A. Sliding clamp. Clamp loader. DNA polymerases epsilon and delta. DNA polymerase beta. DNA polymerase gamma. Other DNA polymerases in eukaryotes. TLS DNA polymerases. Maturation of Okazaki fragments in eukaryotes. Nuclease FEN 1 and nuclease Dna2. Replicative DNA helicases in eukaryotes. Initiation of replication. DNA replication factory hypothesis. Other known replication mechanisms. Rolling circle DNA replication. Bacteriophage fiX174 DNA replication. Plasmid DNA replication by rolling circle mechanism. Tetha DNA replication. Replication by D loop. Linear DNA end replication problem. Replication of adenovirus DNA. Telomeres and their structure. Structure of shelterin complex. Telomere t-loops. Structure and functions of telomerase.	4		2				**6**	**5**	The same
4. RNA Biosynthesis	**9**		**4**				**13**	**13**	Self-directed learning of the topic-related textbook material (course virtual learning environment), Reading of the topic-related scientific papers and preparation for written analyses 4 and 5 of scientific papers.
RNA Polymerases. Structure and features of prokaryotic and eukaryotic RNA polymerases.	2		1				**3**	**4**	The same
Transcription in prokaryotes. Transcription cycle. Recognition of bacterial promoters. Sigma factors and their features. Bacterial promoters, their structure and features. Transcription elongation and termination in bacteria. Regulation of transcription in prokaryotes. Operon.	3		1				**4**	**4**	The same
Transcription in eukaryotes. RNA polymerase I. Promoters of RNA pol I and assembly of the transcription complex. RNA polymerase III. Promoters of RNA pol III and assembly of the	4		2				**6**	**5**	The same

transcription complex. RNA polymerase II. Promoters of RNA pol II and assembly of the transcription complex. Mediator, its structure and the role in transcription. Regulation of transcription in eukaryotes. Activation of transcription. Response elements. DNA recognition motives of transcription factors. Gene regulation by RNA interference.									
Laboratory works									
1. Isolation of chromosomal DNA from eukaryotic cells					10		**10**	3	Self-directed learning of the topic-related textbook material, preparation for laboratory work and preparation of Lab Report.
2. Isolation of plasmid DNA from bacterial cells								2	The same
3. DNA spectral and restriction analysis								2	The same
4. Virtual analysis of target DNA sequences and primer design					8		**8**	4	The same
5. Optimisation of PCR and target identification								2	The same
6. Modifications of PCR (multiplex PCR, nested PCR)								2	The same
7. Purification of total bacterial RNA					14		**14**	3	The same
8. Accession of bacterial transcription by Northern analysis								3	The same
9. Accession of bacterial transcription by reverse-transcription -PCR								2	The same
Total	**32**		**16**		**32**		**80**	**70**	

Assessment strategy	**Weight,%**	**Assessment period**	**Assessment criteria**
Midterm exam	30	9-10th week of the course	Test (virtual learning environment) of 50 questions from topics 1-2. <24 answered questions - 2-4 (insufficient) 24 answered questions - 5 (sufficient) 25-29 answered questions -6 (satisfactory) 30-34 answered questions - 7(highly satisfactory) 35-39 answered questions -8 (good) 40-44 answered questions -9 (very good) 45-50 answered questions -10 (excellent)
Completion of laboratory works, preparation and defence of laboratory work reports.	15	The final exam is allowed only when all laboratory works are completed, practical work reports prepared and defended until 16th week of the course.	2-4 (insufficient) 5 (sufficient) 6 (satisfactory) 7(highly satisfactory) 8 (good) 9 (very good) 10 (excellent)
Written analysis	15	The final exam is	2-4 (insufficient)

of scientific papers		allowed only upon completion of scientific paper analyses 1-5 until 16th week of the course.	5 (sufficient) 6 (satisfactory) 7(highly satisfactory) 8 (good) 9 (very good) 10 (excellent)
Class participation	-	During lectures and seminars.	Class participation will be awarded by the 0/1 points depending on the level of involvement during in-class activities, by the quantity and quality of contributions during seminars. The points, received during semester can be added to either midterm or exam test points.
Final exam	40	Exam session	Test (virtual learning environment) of 50 questions from topics 3-4 <24 answered questions - 2-4 (insufficient) 24 answered questions - 5 (sufficient) 25-29 answered questions -6 (satisfactory) 30-34 answered questions - 7(highly satisfactory) 35-39 answered questions -8 (good) 40-44 answered questions -9 (very good) 45-50 answered questions -10 (excellent)
Total	100		All course parts must be completed at least with the minimal evaluation (sufficient, 5) to obtain the finalgrade. The final grade is the sum of all evaluated parts.

Author	Year of publica-tion	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
Molecular biology	Since 2012	Course virtual learning environment (lectures, scientific papers, PDF materials of instructor textbook)		http://vma.esec.vu.lt
Allison L.A.	2011	Fundamental Molecular Biology.		Blackwell Publishing
Šeputienė V, Bagdonienė L, Labeikytė D, Sasnauskienė S.	2008	Molecular biology practical classes (in Lithuanian)		Technologija, Kaunas
Optional reading				
Ed. by Krebs JE, Goldstein ES and Kilpatrick ST	2011	Lewin‘s genes X.		Jones and Bartlett Publishers