MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
STATE UNIVERSITY
«UZHHOROD NATIONAL UNIVERSITY»
MEDICAL FACULTY 2
DEPARTMENT OF FUNDAMENTAL MEDICAL DISCIPLINES

"APPROVED"
Dean of the Medical Faculty №2
Prof. Kaliy V.V.
"____" _____ 2021

THE WORKING PROGRAM OF THE EDUCATIONAL DISCIPLINE "MOLECULAR BIOLOGY"

Educational degree	**Master**
Studying direction	**22 "Health Care"**
Specialty	**222 "Medicine"**
Educational program	**General medicine**
Discipline status	**Required**
The language of instruction	**English**

Uzhhorod 2021

The working program of Molecular Biology for international students with English language of studying, the studing direction 22 "Health Care", specialty 222 "Medicine"

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The working program approved at the meeting of the Department of Fundamental Medical Disciplines, Protocol №7, June 18, 2021.

Head of the Department of
Fundamental Medical Disciplines _____ Prof. Feketa V.P.

Approved by the Scientific and Methodical Commission of the Medical faculty
Protocol №6, June 29, 2021

Head of the Scientific and Methodical Commission _____ Malets N.B.

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1. DESCRIPTION OF THE SUBJECT

<table>
<tr><td>Name of indicators</td><td>Branch of knowledge, studing direction, education degree</td><td>Characteristics of the subject
Full-time education</td></tr>
<tr><td rowspan="2">Credits – 2</td><td>Branch of knowledge
“Molecular Biology”
(OK 21).</td><td rowspan="2">Regulatory (optional)</td></tr>
<tr><td>Studing direction
22 “Health Care”</td></tr>
<tr><td>Modules – 2</td><td rowspan="4">Speciality
222 “Medicine”</td><td>Year of studing:</td></tr>
<tr><td>Submodules – 2</td><td>1st</td></tr>
<tr><td>Individual research task
_____</td><td>Semester</td></tr>
<tr><td>The total number of hours – 526</td><td>2nd</td></tr>
<tr><td rowspan="10">Weekly hours in laboratory – 2</td><td rowspan="10">Education degree:
Master</td><td>Lectures</td></tr>
<tr><td>No lectures</td></tr>
<tr><td>Practicals</td></tr>
<tr><td>510 hours</td></tr>
<tr><td>Laboratory classes</td></tr>
<tr><td>64 hours</td></tr>
<tr><td>Individual work</td></tr>
<tr><td>178 hours</td></tr>
<tr><td>Individual tasks:
hours</td></tr>
<tr><td>Types of evaluation: via
MCQs quizzes, assays, presentations.</td></tr>
</table>

2. THE AIM OF THE EDUCATIONAL DISCIPLINE

Molecular biology as an academic discipline:

a) based on previously studied in secondary or high school subjects, such as General Biology, Human Biology

b) ensures a high level of general biological training;

c) provides students with a fundamentals for further assimilation of knowledge of relevant theoretical and practical clinical professional disciplines (medical chemistry and pharmacology, immunology, embryology, epidemiology, etc.).

According to the Bologna Declaration, the organization of education is carried out by a credit-modular system. The program of “Molecular biology” is structured into 1 module containing 3 thematic submodules.

The students' study process includes: a) laboratory tutorials b) laboratory works c) workshops, seminars d) individual work of students e) submodule and module controls f) consultations g) exam. Tests questions, case problems solving, cytochemical identification of the macromolecular substances in tissue preparations and into solutions will be applied during training of students. Controls of students' studies are prepared during and at the end of each of modules as multiple choice questions testing and final evaluation at the end of fall semester. Topics laboratory works, workshops, etc. reveal issues relevant to different sections of Molecular biology.

Learning goals

The main learning goal for students is to gain useful knowledge from study of Molecular biology, which they could apply in their professional work or use this knowledge as a theoretical basis in future biomedical studies and medicinal practice.

Students will understand the life on molecular level. They will gain skills in molecular diagnostic methods which may be required for their future work in medicine and methods used in molecular biology scientific laboratories. Students will learn how to implement scientific method by suggesting hypotheses for explanation of biomedical phenomena, designing and conducting simple experimental studies to test these hypotheses and critically evaluate their results. They will learn to present their data using and analyse the world scientific literature on the particular problem.

By learning Molecular Biology, our students receive the knowledge, contributing to the theoretical multidisciplinary basis of their future profession. They learn theoretical topics and an array of molecular methods, particularly, for identification some hereditary diseases, cancers, viruses and human parasites.

After completing the course students **must know**:

- the basic principles of Molecular biology;
- the basics of life on the level of macromolecules in cell;
- the principles of modern molecular techniques and methods of diagnostics.

At the end of the Molecular biology studies students **must be able**:

- to determine the diseases that result from changes in the DNA nucleotide sequences.
- to identify macromolecular complexes in cells using cytochemical methods
- to explain the cell functioning on molecular levels.
- to carry out qualitative reactions for DNA, RNA, proteins, carbohydrates and lipids
- to carry out simple laboratory experiments for studies of four classes of biological macromolecules, the DNA, RNA, proteins, lipids, carbohydrates (centrifugations, thin layer chromatography, gel electrophoresis, polymerase chain reaction, photocolorimetry, spectrophotometry, etc).

3. THE COMPETENCES ACCORDING TO PROGRAM

Integral competences.

Ability to solve typical and complex biomedical problems during learning and practical problems in a professional health care activity, particularly, the genetic consulting, diagnostics or in a learning process that involves research and/or innovation and is characterized by the complexity and uncertainty of conditions and requirements. According to the program, the study of discipline promotes the formation of the following **general competences (GC)** in students:

GC 1. Ability to abstract thinking, analysis and synthesis.
GC 2. Ability to learn and master modern knowledge.
GC 3. Ability to apply knowledge in practical situations.
GC 4. Knowledge and understanding of the subject area and of professional activity.
GC 5. Ability to adapt and act in a new situation.
GC 6. Ability to make informed decisions.
GC 11. Skills in the use of information and communication technologies.

Specialized competences

Ability to evaluate the results molecular biology laboratory and instrumental studies.

4. PREREQUISITES FOR STUDY DISCIPLINE

Prerequisites for studying the discipline "Molecular Biology" are basic knowledge in Biology and Chemistry from secondary school.

5. EXPECTED LEARNING RESULTS

By the program "Molecular Biology", the study of the discipline should ensure the achievement of the following planned results of study in students (PRS):

Planned results of study	Code of PRS
Evaluate information based on the results of laboratory studies.	PRS 2
Highlight the leading clinical symptom or syndrome. Establish a preliminary and clinical diagnosis.	PRS 3

Expected learning outcomes (ELO) that must be achieved by the recipients of education after completing the course "Molecular Biology":

ELO	Expected learning outcomes of the discipline	Code of PRS
ELO 1	Ability to estimate on the basis of laboratory data of the molecular biology cause of heritable disease (sickle cell anemia, Tay-Sachs disease, Duchenne muscular dystrophy, phenylketonuria, etc.)	PRS 3
ELO 2	Ability to estimate on the basis of molecular laboratory data the systemic diseases (babesiasis, toxoplasmosis, etc.)	PRS 3
ELO 3	Ability to estimate on the basis of molecular laboratory data the parasitic diseases in the urinary system (trichomoniasis, etc.)	PRS 3
ELO 4	Ability to estimate on the basis of molecular laboratory data the viral diseases (coronaviruses, human papilloma virus, etc.).	PRS 3
ELO 5	Ability to interpret the molecular causes of hereditary and parasitary (including parasitic, bacterial and virus like particles) diseases mechanisms and symptoms.	PRS 3
ELO 6	Ability to determine the principles and character of treatment	PRS 6

6. DIAGNOSTICS AND ASSESSMENT CRITERIA OF LEARNING RESULTS

Assessment tools and methods for demonstrating learning outcomes

Means of assessment and methods of demonstrating the results of training in the discipline are:

ELO 1. - test tasks, theoretical questions, situational task (medical history, general blood test, molecular biology laboratory test, pedigree analysis for human heritable diseases).

ELO 2. - test tasks, theoretical questions, diagnosis and characterization of major genetic diseases on the molecular levels.

ELO 3. - test tasks, theoretical questions, situational problem (medical history, polymerase chain reaction (PCR) analysis for parasites, biochemical analysis).

ELO 4. - test tasks, theoretical questions, diagnostics and characterization of viral diseases on molecular level, interpretation of PCR diagnostics results.

ELO 5. - test tasks, theoretical questions, interpretation of clinical situational problems, instrumental and laboratory methods and interpretation of experimental results.

ELO 6. - test tasks, theoretical questions, interpretation of clinical situational problems, instrumental and laboratory methods and interpretation of experimental results.

7. MOLECULAR BIOLOGY PROGRAM

Spring Semester.

Module 1. Nucleic acids, proteins, lipids and carbohydrates.

Submodule 1. Nucleic acids: structure, functions and methods of studies.

The structures and functions of DNA and RNA. Physical and chemical properties of nucleic acids. Levels of organization of nucleic acids. The primary structure of DNA and RNA. Nucleotide structure. Secondary structure of DNA. The nature of the forces that stabilize the structure of nucleic acids. A variety of forms of the DNA double helix. Linear and circular closed DNAs. RNA types. Transfer RNA. Secondary and tertiary structure of tRNA.

Replication and transcription. Semi-conservative mechanism of DNA replication. Enzymatic apparatus of DNA-dependent DNA synthesis. DNA polymerases of pro- and eukaryotes. Replicative fork. Bidirectional and unidirectional replication. RNA priming. "Proofreading" of newly synthesized DNA. DNA repair and modification. Unraveling of the double helix of DNA. Topoisomerases. Features of replication in RNA-containing viruses. Reverse transcription, functioning of RNA-dependent DNA polymers. Use of reverse transcriptase in genetic engineering for gene synthesis.

Transcription. Transcription in prokaryotes. DNA-dependent RNA polymerase. Initiation. Promoter. Elongation of the RNA chain. Termination. Prokaryotic mRNA molecules. Transcription blocks of rRNA genes.

Transcription and processing in eukaryotes. DNA-dependent RNA polymerases. RNA synthesis. mRNA molecules. The role and place of splicing. Modification of the 5 ' end of the mRNA. Regulation of transcription. tRNA and rRNA processing. mRNA and its role.

Theory "One gene-one enzyme". Determination of amino acid sequence through mRNA. Genetic code. Non-overlapping code. Coding of amino acids. Direction of

reading. "Degeneracy" of the code. The "swing" hypothesis. Reading frame. Mutation. Silent mutation. Replacement (missense mutation). Mutation with frame shift. Universality of the genetic code. Deciphering the genetic code.

Molecular biology of DNA-containing and RNA-containing viruses. DNA-containing viruses. Molecular composition of the virus. Spiral capsids. Icosahedral capsids. Complex capsids without shells. Component capsids with a shell. Adsorption. Infection. Penetration of viral DNA. Transcription and replication. Translation of viral mRNA. Assembly of virus components. RNA-containing viruses. Molecular composition of the virus. Viruses with double-stranded and single-stranded RNA. Infectious process, replication of reoviruses, influenza virus, retroviruses. Coronaviruses.

Organization and expression of the genome of prokaryotes. DNA in prokaryotes. Organization of the genome of prokaryotes. Structural genes. Chromosome of prokaryotes: independent genes, transcription units, operons. Spacer DNA. Plasmids. Palindromes. Mobile elements of the genome. Transposons. Features of the genome of viruses that affect prokaryotes. Gene overlap. Regulation of gene expression in prokaryotes. Induction of enzyme synthesis. Repressor. Operator. Promoter. Inductor. Repression. Tryptophan operon. Lactose operon. Variation of transcript length. Positive regulation.

Organization and expression of the eukaryotic genome. DNA in eukaryotic cells. Condensation, spheroidal twisting of DNA. Supercoiled DNA. Stabilization of compact forms of DNA. DNA packaging in prokaryotic and eukaryotic cells. Chromatin. Nucleosome. Salt-like structure of cellular chromatin. Chromosomal structural proteins. Intron-exon structure of eukaryotic genes. "Redundancy" of the genome. Independent genes. Duplicate genes. Gene clusters. Satellite DNA. Genes of viruses that affect eukaryotes. DNA- and RNA-containing viruses. Chromosomes of eukaryotes. Levels of structural organization of chromatin. Histones. Nucleosomes.

Regulation of gene expression in eukaryotes. Regulation at the level of transcription. Post-transcriptive regulation. Regulation at the broadcast level. Post-translational regulation. Regulation by hormones.

The structure of ribosomes and protein biosynthesis.

Cell translation apparatus. Decoding. Activation of tRNA. Ribosomes. Ribosome structure, physicochemical properties of ribosomes. Dissociation of ribosomes. Ribosomal RNA. Ribosomal proteins. Self-assembly of a functional ribosome. Ribosome binding sites. Polysome or polyribosome. Association of mRNA and ribosomes. Informosomes. RNA-binding proteins, their role in the functioning of mRNA.

Transfer RNA: properties, primary and spatial structure. Adaptive function of tRNA in the process of mRNA translation. Aminoacyl-tRNA synthetase: structure and functions. The problem of tRNA recognition. Catalytic mechanism of aminoacylation reaction. Translation of the genetic code. Initiation, elongation, termination. Peptide bond formation. Translocation. Broadcast in prokaryotes and eukaryotes. Broadcast factors. Accuracy and speed of translation. Posttranslational modification of proteins.

Methods. Using microscopy to detect nucleic acids inside cells. Staining of DNA and RNA molecules with specific fluorescent and non-fluorescent dyes. Microscopic autoradiography for detection of radioactive molecules in cells. Methods of visualization of individual molecules using scanning-testing microscopes. Scanning Tunneling microscopy. Atomic force microscopy.

Centrifugation and subcellular fractionation. The role of nucleic acid size and density for their separation during centrifugation. The size of molecules and organelles of cells as the main factor of their separation in high-speed centrifugation. Iso density centrifugation to separate molecules and organelles by density. Differential centrifugation to divide cells into nuclear, mitochondrial, microsomal and cytosolic fractions of the cell.

Methods of research of macromolecules. Ultracentrifugation and sedimentation behavior of nucleic acids. Spectrophotometry to detect and determine the concentration of nucleic acids. Use of radioisotopes. Labeling of nucleic acids and their hybridization. Determination of the content of nitrogenous bases by the melting point of DNA. Isolation, purification and fractionation of nucleic acids. Sequencing of nucleic acids. Selective precipitation. Chromatography. X-ray structural analysis. Electrophoresis method. Purification and separation of nucleic acids. Separation of DNA in gel electrophoresis. DNA cloning. Restriction analysis. Chemical synthesis and site-directed mutagenesis. Southern and Nothern blotting. Transferred genes to eukaryotic cells and mammalian embryos. Enzymatic amplification of DNA by polymerase chain reaction. Nucleic acid sequencing. Feulgen staining of nuclear DNA in eukaryotic cells. Hoechst or DAPI staining of DNA in eukaryotic and prokaryotic cells.Methyl green-pyronin method for DNA and RNA detection in cells. Isolation of bacterial genomic DNA. Guanine and cytosine content determination in DNA. RNA isolation by acid guanidinium thiocyanate-phenol-chlorophorm extraction method of P.Chomczynski and N.Sacchi. Determination of RNA: DNA ratio in mammalian liver tissue. Denaturating gel-electrophoresis of RNA. Agarose gel-electrophoresis of DNA. Polymerase chain reaction methods and their use in diagnostics. Coronaviruses PCR diagnostics. Restrictases and ligase. Restriction mapping. Southern and Northern blotting. Microarrays and their use in research and diagnostics. Molecular fingerprinting and diagnostic RFLP, SNP methods. Determination of DNA, RNA and phosphoproteins i animal tissue by the method of G. Schmidt, S.J. Thannhauser.

Submodule 2. Proteins: structure, functions and methods of studies.

Structure and functions of proteins. The primary structure of proteins and properties conferred to them by amino acids. Amino acid residues. Free amino acid. Peptide bond. Polypeptide chain. Amino acid sequence. Classification of side groups. Stereoisomerism. Energy and strength in the structure of the protein molecule. Free energy and its change. Covalent and non-covalent bonds. Stability of a folded protein molecule. The role of electrostatic effects, ionic bonds (salt bridges), hydrogen bonds, van der Waals forces, hydrophobic interactions, and disulphide bridges in maintaining protein structure.

The role of water. Thermal motion. Conformation of peptides. Trans- and cis-conformation of the peptide group. Angles φ and ψ. Ramachandran's information map. Secondary structure of protein. Regular structures: α-helix, β-layers, β-bends. Collagen spiral. α- and β-structures of proteins. The structure of fibrillar proteins. Collagen. Silk. Keratin. Tropomyosin. Tertiary and Quaternary protein structure. The structure of globular proteins. Myoglobin. Hemoglobin. Denaturation and renaturation of a protein molecule. Stability of a collapsed molecule. Domains. Subunits. Packing of subunits. Internal mobility of proteins. Protein synthesis in prokaryotes and eukaryotes. Chaperonins.

Membrane proteins. Radioactive labeling in the study of their orientation. Proteins are integral, peripheral and fixed in lipids. Proteins moving in the lipid bilayer. Variations

in the mobility of membrane proteins. Asymmetric orientation of membrane proteins. Protein subunits. Transport across membranes: diffusion, osmosis, simple diffusion, membrane transport. The need for energy. Accelerated diffusion by electrochemical gradient. Glucose transport. Protein Band 3 - anion exchanger. Ion channels for small ions. Energy for active transport. Transport of amino acids and sugars. Membrane potentials and nerve impulses. Bacterial cell wall. Membrane mitochondria.

*Proteins as enzymes, transporters, hormones.*Enzymes: nature and principles of action. Regulation of enzymatic activity. Lysozyme. Carrier proteins: globins. The action of some vertebrate hormones.

Molecular basis of movement in non-muscle cells. Muscles and their contractions.

Cellular mobility. Microtubules. Proteins associated with microtubules. Axonema. Sliding thread model. Microfilaments. Rarefaction-reduction model.

Smooth and striated muscles of vertebrates. Skeletal muscles, heart muscle. Myofibrils. Sarcolemma. Sarcoplasm. Isotropic and anisotropic bands, H-zone, line M, Z-line, sarcomere. Muscle threads. Actin. Tropomyosin. Troponin. The cycle of tilting the heads of myosin. Regulation of muscle activity.

Methods. Using microscopy to detect molecules inside cells. Staining of specific molecules using dyes. Detection of proteins and other antigens in the cell using antibodies. Localization of the activity of specific enzymes in cells using cytochemical procedures. Microscopic autoradiography for detection of radioactive molecules in cells. Methods of visualization of individual molecules using scanning-testing microscopes.

Centrifugation and subcellular fractionation. The role of size and density for their separation during centrifugation. The size of molecules and organelles of cells as the main factor of their separation in high-speed centrifugation. Isodensity centrifugation to separate molecules and organelles by density. Differential centrifugation to divide cells into nuclear, mitochondrial, microsomal and cytosolic fractions of the cell.

Methods of research of macromolecules. Ultracentrifugation and sedimentation behavior of proteins. Spectrophotometry to detect and determine the concentration of nucleic acids. Use of radioisotopes. The use of antibodies. Monoclonal antibody method. Dialysis and precipitation to separate large and small molecules. Isolation, purification and fractionation of proteins. Sequencing of proteins. Selective precipitation. Chromatography. X-ray structural analysis. Electrophoresis method. Purification and separation of proteins. Isolation and properties studies of bacteriorhodopsin, a light-sensitive protein. Sedimentation reactions of proteins. Acidic hydrolysis of nucleoproteins and qualitative reactions for hydrolysis products. Qualitative reactions for proteins and amino acids. Thin layer chromatography of amino acids. SDS-PAGE gel-electrophoresis of proteins. Isoelectric focusing and 2D gel electrophoresis of total cell proteins. Western blotting or immunoblotting. Protein sequencing from C and N ends. Study of the enzyme catecholoxidase. Study of amylase, the human saliva enzyme. Spectrophotometric quantitative determination of protein in human liquids. Protein arrays.

Submodule 3. Lipids and carbohydrates: structure, functions and methods of studies.

Structure and functions of lipids. Fats. Saturated and unsaturated fatty acids, natural, essential fatty acids. Glycerol. Amphipatic lipids. Steroids. Phospholipids. Non-glycerol

lipids: Sphingosine. Ceramide. Cerebrosides. Phosphosphingolipids. Gangliosides. Simple lipids: steroids and terpenes.

Plasma membrane: summary of functions, overview of the structure. Membrane lipids, double lipid layer. Spontaneous formation of a double layer of membrane lipids. Membrane fluidity and the effect on it of changes in lipid composition. Asymmetric placement of lipids in the double layer. Models of plasma membrane. The last model of plasma membrane. Membranes in an electron microscope.

Methods. Production of liposomes for substances, particularly, drugs delivery.

Single step lipid extraction from tissues and qualitative reactions for lipids. Lipids separation by thin-layer chromatography. Other methods for studies of lipids.

Structure and functions of carbohydrates. The structure of simple sugars. D-glucose. Stereoisomerism. Glycoside bond. Oligosaccharides. Polysaccharides. Cellulose. Starch. Glycogen. Chitin. Hyaluronic acid. Glycosaminoglycans.

Methods. Qualitative reactions for carbohydrates. Thin layer chromatography of carbohydrates. Glycans arrays. Other methods for studies of carbohydrates.

Topics for molecular biology assays and presentations

1. Polymerase chain reaction (PCR) types
2. PCR testing of hereditary diseases.
3. PCR testing for coronaviruses.
4. PCR testing for parasites.
5. PCR testing for toxoplasma.
6. PCR testing for HIV.
7. PCR testing for coronaviruses.
8. PCR testing for trichomoniasis.
9. PCR testing for human papilloma virus.
10. Aggregation of lipids and production of liposomes for drug delivery
11. Immobilization of enzymes.
12. Example of success in gene terapy.
13. Methods of the sequencing of nucleotide sequences of DNA.
14. My favorite method of molecular biology.
15. Telomeres, telomerase: aging, cancer.
16. Chemical-enzymatic synthesis of genes.
17. Translation in eukaryotes.
18. Translation in prokaryotes.
19. Molecular chaperonins and their role in folding polypeptides.
20. RNA replicates and prospects and extracellular protein synthesis.
21. Role of recombinant DNA technology to improve life
22. Fluorescence assays to detect DNA and/or RNA in cell.
23. Fluorescence assays to detect proteins in cell.
24. Gradient centrifugation.
25. Functionality of DNA and RNA
26. Proteins microarray
27. Glycans microarray
28. Carbohydrates in cell recognition.
29. Genes and obesity.

8. THE STRUCTURE OF THE SUBJECT

Fall Semester

Module 1. Nucleic acids, proteins, lipids and carbohydrates.

№	Laboratory lessons	Hours	Individual students' work
	Submodule 1. Nucleic acids: structure, functions and methods of studies.		
1	Feulgen staining of nuclear DNA in eukaryotic cells	2	4
2	Hoechst or DAPI staining of DNA in eukaryotic and prokaryotic cells	2	4
3	Methyl green-pyronin method for DNA and RNA detection in cells	2	4
4	Isolation of bacterial genomic DNA	2	4
5	Guanine and cytosine content determination in DNA	2	4
6	RNA isolation by acid guanidinium thiocyanate-phenol-chlorophorm extraction method of P.Chomczynski and N.Sacchi	2	4
7	Determination of RNA: DNA ratio in mammalian liver tissue	2	4
8	Denaturating gel-electrophoresis of RNA.	2	4
9	Agarose gel-electrophoresis of DNA.	2	4
10	DNA sequencing.	2	4
11	Polymerase chain reaction methods and their use in diagnostics.	2	4
12	Restrictases and ligase. Restriction mapping.	2	4
13	Southern and Northern blotting.	2	4
14	Microarrays and their use in research and diagnostics.	2	4
15	Molecular fingerprinting and diagnostic RFLP, SNP methods.	2	4
16	Determination of DNA, RNA and phosphoproteins i animal tissue by the method of G. Schmidt, S.J. Thannhauser.	2	4
	Submodule 2. Proteins: structure, functions and methods of studies.		
17	Isolation and properties studies of bacteriorhodopsin, a light-sensitive protein.	2	4
18	Sedimentation reactions of proteins.	2	4
19	Acidic hydrolysis of nucleoproteins and qualitative reactions for hydrolysis products.	2	4
20	Qualitative reactions for proteins and amino acids.	2	4
21	Thin layer chromatography of amino acids.	2	4
22	SDS-PAGE gel-electrophoresis of proteins.	2	4
23	Isoelectric focusing and 2D gel electrophoresis of total cell proteins.		4
24	Western blotting or immunoblotting.	2	4
25	Protein sequencing from C and N ends.	2	4
26	Study of the enzyme catecholoxidase.	2	4
27	Study of amylase, the human saliva enzyme.		4
28	Spectrophotometric quantitative determination of protein in human liquids.	2	4
	Submodule 3. Lipids and carbohydrates: structure, functions and methods of studies.		
29	Single step lipid extraction from tissues and qualitative reactions for lipids.	2	4
30	Lipids separation by thin-layer chromatography	2	4
31	Qualitative reactions for carbohydrates.	2	4
32	Thin layer chromatography of carbohydrates.	2	4
	Total hours for laboratory lessons	64	128

*There are no lectures planned for year 2021-2022.

9. Individual work

Individual students work is performed by studing from text-books, information obtained on lectures, laboratory lessons and materials from Internet and scientific literature on the topics, writing of assays and preparing of presentations.

№	Module 1	Hours	Evaluation
1.	Preparation for laboratory classes - theoretical preparation and practical skills from lessons.	128	Current control on laboratory classes. ECTS rating.
2.	Short assay	20	max score 5
3.	PowerPoint presentation	20	max score 5
4.	Submodule 1 control test	2	ECTS rating
5.	Submodule 2 control test	2	ECTS rating
6.	Submodule 3 control test	2	ECTS rating
8.	Module 1 final test	2	ECTS rating
	Total	156	

As a part of individual work, each student must select one question (from listed above or from laboratory lessons section) for preparation as short, 500 words long assay (≈ 1 page, single spacing Times New Roman, 12pt with standard margins) and PowerPoint presentation (no more than 25 slides).

10. Teaching methods

1. Illustrative and explanatory method – students acquire knowledges at a lecture using educational or instructional materials. Students perceive and comprehend the facts, assessments, conclusions and remain within the reproductive (reproducing) thinking. This method is widely used in high school to transfer large amounts of information.

2. The reproductive method (useful for studying samples of blood, urine, instrumental research).

Knowledge learned from the sample or rules under which students work is algorithmic in nature that is performed by instructions, rules similar to the model shown. Organized activities for students to digest the knowledge. It uses a variety of exercises, laboratory and practical work, programmable control, and various forms of self-control. It is used in conjunction with information receptive methods (prior to the reproductive). Together, they contribute to the formation of knowledge, skills and abilities in the students to form the basic mental operations (analysis, synthesis, transfer, classification).

3. The method of problem presentation.

Teacher presents the problem formulated cognitive tasks based on different sources and means, then together with students develops a way to solve the problem. This is achieved through the disclosure of arguments, comparing points of view, and different approaches. With this method, students become witnesses and accomplices in scientific research; follow the logic of evidence, the movement of teacher's thought. For the purpose of studying the subject in lectures and practical classes, teachers use mainly problem-oriented approaches, along with interactive methods of teaching.

4. Research method (for individual students work).

Students study literature sources, monitoring and perform other research actions. Tasks performed by using research methods should include all the elements of the independent research process (problem definition, rationale, assumptions, search for appropriate sources of relevant information, process of problem solving). This method is most fully manifested initiative, independence, creativity in research.

11. Evaluations

Current control is carried out in each class according to specific goals for each topic. In assessing students' educational activity should prefer standardized methods of control: testing, structured written work, a structured procedure for the control of practical skills.

The maximum score student can get for each module (or submodule) is 200, the minimum to pass the module (or submodule) is 120.

Total points for all types of studies	Rate ECTS	Rate according to national scale	
		for exam, course project (work), practice	for credit
180 – 200	**A**	well	Accepted
164-179	**B**	fine	
148-163	**C**		
128-147	**D**	satisfactorily	
120-127	**E**		
70-119	**FX**	Unsatisfactorily with the possibility of re-passing	Unaccepted with the possibility of re-passing
0-69	**F**	unsatisfactorily with obligatory repeated studing of the subject	Unaccepted with obligatory repeated studing of the subject

In order to pass the module (or submodule) students must attend and receive positive marks for all the laboratory works in this module (or submodule) with a score of at least 120 for each. The objectivity of the current evaluation on lessons must be checked by writing the submodules and final module evaluation, which are compulsory for all students and cover theoretical and practical questions from laboratory lessons too. Answering 60% and more of questions correctly is considered a passing mark for final module test or for final exam writing. In case of submodule failure, students can rework it by writing the final module evaluation. One attempt is allowed to rewrite the final module evaluation, if someone failed to get a positive mark from its first writing. There are no more reworks allowed, if failed again. In that case students must attend the final exam evaluation by writing. Two reworks are possible for final exam evaluation during examination session.

The valuation of discipline FX, assigned to students who were not enrolled at least in one module from discipline after completion of the study or have scored less than 120 for final module or exam. This allows further reworks. F- scored students (not completed the subject with at least one module or don`t get minimum points for current educational activity module) must undergo re-training according to their individual educational plan.

All the assays and presentations will be evaluated in the "2-5" points approach. Best presentations (with maximum score "5") will be recommended for uploading on SlideShare website on the Internet. The marks for these individual works will be added to scores collected from the submodules evaluations writings.

13. Equipment.

We are using simple and safe for student laboratory equipment (different kinds of light microscopes, spectrophotometry, photoelectric colorimeter, ionometers) and materials. We are using modern projectors for our presentations, videos and many videos from Internet to illustrate the complicated methods and biological processes also. Students must come to laboratory lessons in their own white robes.

14. Methodological software

Moodle, Excell, Origin, PowerPoint, e-learn, etc.

Recommended Literature:

Basic

1. Lodish H. et al. Molecular cell biology W.H. Freeman and Company One New York Plaza, 2016.- 1278 p.
2. Roberts M.F., Kruchten A.E. Receptor Biology.- Wiley-VCH.- Verlag GmbH & Co KGaA.- Weinheim, 2016.- 267 p.
3. Iwasa J., Marshall W. Karp's Cell and molecular biology. Concepts & experiments.- 8th Ed., John Wiley & Sons, Inc., 2016– 829 p.
4. Alberts B., Johnson A., Lewis J., Morgan D., Raff M., Roberts K., Walter P.; Molecular biology of the cell. - 2015.- 6th ed. -1465 p.
5. Wilson J., Hunt T. Molecular biology of the cell. - The Problems Book .- 2015.- 6 th ed. – 966 p.Mousumi Debnath Godavarthi B.K.S. Prasad, Prakash S. Bisen Molecular Diagnostics: Promises and Possibilities.- Springer, Dordrecht Heidelberg London New York.- 2010.- 511p.
6. Cagle P.T., Allen T.C. (Eds.) Basic Concepts of Molecular Pathology.- Springer 2009.- 195 p.
7. René Fester Kratz Molecular & Cell Biology For Dummies.- Wiley Publishing, Inc., Wiley Publishing, Inc., Indianapolis, Indiana.- 2009.- 389 p.
8. David Clark Molecular biology, Elsevier Inc., 2005.- 802 p.
9. Sandeep Hooda (Ed.) Cell, Molecular Biology and Biotechnology.- Vardhman Mahaveer Open University, Kota - 363 p.
10. Sharga B.M., Pylypiv D.B., Feketa V.P. MOLECULAR BIOLOGY PRACTICALS. Practical 2. Hoechst or DAPI staining of DNA in eukaryotic and bacterial cells.- https://www.researchgate.net/publication/339943173
11. Sharga B.M., Pylypiv D.B., Feketa V.P..- Feulgen staining of nuclear DNA in eukaryotic cells.- https://www.researchgate.net/publication/339942360
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*Each protocol for laboratory work contains the list of references also.