MINISTRY OF HEALTH OF UKRAINE
Danylo Halytsky Lviv National Medical University
Department of Microbiology

"APPROVED"
The First vice-rector for scientific and pedagogical work
Assos.Prof. Iryna SOLONYNKO
* _____ * _____ 2023 p.

EDUCATION CURRICULUM OF DISCIPLINE
VB 1.32 "Microorganisms in biotechnological processes"

(elective course)
for training specialists
of the second (master's) level of higher education
field of study - 22 "Health Care",
specialty 226 "Pharmacy, industrial pharmacy"
for second-year students

Discussed and **approved**
at the methodical meeting of
Department of Microbiology
Protocol № 14
Dated "12 June" 2023
Head of the Department

prof. Olena KORNIYCHUK, MD

Approved at the sitting of the cycle
the profile methodical commission
in Preventive Medicine
Protocol №4
Dated 15" "June 2023
Head of the profile methodical commission

prof. Vira FEDORENKO.MD

Lviv - 2023

The program was made by the staff of the Department of Microbiology of Danylo Halytskyi Lviv National Medical University: Head of the Department, Doctor of Medicine, Professor O Korniychuk, Ph.D., Associate Professor L.Burova ., Ph.D.Senior Lecturer H.Lavryk., Ph.D. Associate Professor Pavliy S.

The program was discussed and approved at the meeting of the Department of Microbiology on June 12, 2023. (protocol № 14) and the meeting of the cycle methodical commission on preventive medicine on June 15, 2023 (protocol) No. 4

INTRODUCTION

The program of study of the discipline "Microorganisms in biotechnological processes processes" is drawn up in accordance with the Standard of higher education of the second (master's) level field of knowledge 22 "Health care" specialty 226 "Pharmacy, industrial pharmacy" of the educational program Master of Pharmacy

Approved and put into effect by the order of the Ministry of Education and Science of Ukraine dated 04 November 2022 № 981.

Description of the academic discipline

According to the curriculum, the discipline "Microorganisms in Biotechnological Processes" is studied by third-year students.

The subject of the discipline is the properties of microorganisms that make it possible to microorganisms that allow them to be used in biotechnological processes (features of the genetic apparatus, metabolic activity, reproduction rate, etc.).

At the present stage, microorganisms can be used both as vectors and as a source for obtaining the tools necessary for genetic engineering (enzymes, individual genetic structures, etc.). Biotechnological processes are the most rational way to produce a number of biologically active substances and medicines.

The use of biotechnology in the manufacture of vaccines is particularly important.

"Microorganisms in Biotechnological Processes" as an elective course lays down the basis for students to learn the principles of biotechnological processes, which are based on the knowledge of the disciplines obtained in previous courses, involves the integration of teaching with these disciplines and the application of the knowledge gained in the process of further study and in professional activities. The course is directly course is based on the following disciplines: general and molecular biology, botany, medical and biological physics, genetics, biological chemistry, bioorganic chemistry, normal physiology.

Therefore, in the course "Microorganisms in Biotechnological Processes" it is important for students to learn the basic principles of biotechnological and genetic engineering technologies.

According to the curriculum, the types of student learning activities are: a)practical classes; b) independent work of students. The thematic plans for practical classes and independent work allow students to learn the basic principles of biotechnological and and genetic engineering technologies.

The duration of one practical lesson according to the curriculum and with the standards of the weekly classroom load of students is not less than at least 2 academic hours. According to the method of organization, the classes are aimed at controlling mastering theoretical material and developing practical skills to to solve practical problems.

Current control. Mastery of the topic is monitored during practical classes in accordance with specific goals. Practical classes involve solving situational tasks, mastering modern methods of using microorganisms in biotechnological processes and biotechnological processes and the ability to evaluate the results obtained. The means of control are oral questioning, solving test tasks and situational tasks,mastering practical skills in working with biomaterial.

Self-inducation student's work is one of the organization forms of learning that regulated by the curriculum and performed by the student independently outside outside the classroom. A type of independent work is preparation for practical classes and studying the regulatory framework.

The assessment of student performance in the discipline is a rating and is given on a a multi-point scale as an arithmetic mean of the relevant modules and is defined according to the ECTS system and the scale adopted in Ukraine.

Information volume of the discipline

The discipline is designed to provide 90 hours of study, 3.0 ECTS credits.

Description of the curriculum for the elective course " Microorganisms in biotechnological processes »For students of the Faculty of Pharmacy

Structure of the academic discipline	Number of credits, hours, of them				Year of study, semester	type of control
	Total	Classroom		SEW		
		lectures	practics			
MICROORGANISMS IN BIOTECHNOLOGICAL PROCESSES	**3,0credit/ 90 hr**	**10**	**20**	**60**	3 Year V semester	**credit**

Notes: 1 ECTS credit - 30 hours
Audit workload - 33%, SRS - 67%

1. Purpose and objectives of the discipline

1.1. The purpose is professional training of students majoring in "Pharmacy, Industrial Pharmacy" in order to form and develop their competencies in the field of biotechnological processes, aimed at obtaining the necessary amount of theoretical knowledge and the acquisition of the necessary skills in practical microbiology, useful for understanding and mastering the discipline.

1.2. Main tasks.

 Interpret the biological properties of microorganisms, which is the basis for for their use in biotechnological processes;
 Identify methods and means of biotechnological processes.
 Be able to plan and determine the sequence of stages of genetic engineering technologies.
 Interpret the results of genetic engineering technologies, determine ways to optimise the conditions of biotechnological production**.**

Educational competences

1.3. Competences and learning outcomes, the formation of which ensures study of the discipline (general and special competences).

The discipline provides students with the following competencies: ability to to solve typical and complex specialised problems; ability to solve practical problems in professional activities in the field of health care, or in the process of training that involves microbiological research and/or implementation of innovation, characterised by complexity and uncertainty of conditions and requirements**.**

General:

GC01. Ability to abstract thinking, analysis and synthesis.
GC02. Knowledge and understanding of the subject area; understanding of professional activities.
GC03. Ability to communicate in the state language both orally and in writing.
GC04. Ability to communicate in a foreign language.
GC05. Ability to evaluate and ensure the quality of work performed.
GC07. Ability to exercise their rights and responsibilities as a member of society; awareness of the value of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.
GC08. Ability to preserve and enhance moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of pharmacy, its place in the general system of knowledge about nature and society and in the development of society, technology and technology, use different types and forms of physical activity for active recreation activity for active recreation and healthy lifestyle healthy lifestyle.
GC09. Ability to use information and communication technologies

Special (professional, subject):

PC01. Ability to integrate knowledge and solve complex problems of industrial pharmacy in broad or multidisciplinary contexts pharmacy in broad or multidisciplinary contexts.
PC07. Ability to meet the needs of the healthcare industry in the development and production of essential, affordable, high-quality, effective and safe medicines medicines.
PC17. Ability to organise continuous professional development of specialistson pharmaceutical products and processes in pharmaceutical production.
PC20. Ability to develop specifications and methods for quality control of raw materials, intermediate products and finished raw materials, intermediate products and finished medicines using physical, physicochemical, chemical, microbiological methods and conduct their validation in accordance with the requirements of the current edition of the State Pharmacopoeia of Ukraine

Classification of competences according to the NQF in the form of a "Competence Matrix"

N	**Competence**	**Skills**	**Knowledge**	**Communication**	**Autonomy and responsibility**
1	The ability to abstract thinking, analysis and synthesis.	Specialised conceptual knowledge that including modern scientific achievements in the field of professional activity or field of knowledge and are the basis for original thinking and conducting research, critical understanding of problems in the industry and at the interface of the fields of of knowledge	Specialised skills/abilities solving problems required to carry out research and/or implementation of innovative activities for the purpose of of developing new knowledge and procedures	Clear and unambiguous communication of your own knowledge, conclusions and arguments to specialists and non-specialists, in particular, to people who are studying	Management workforce or learning processes that are are complex, unpredictable and require new strategic approaches
2	Knowledge and understanding of the of the subject area; understanding of professional activities.		Ability to to integrate knowledge and solve complex problems complex problems in broad multidisciplinary multidisciplinary contexts		
3	Ability to communicate in the state language both orallyand in writing.		Ability to to solve problems in new or unfamiliar		

			environments with the presence of incomplete or limited information with taking into account aspects of social and ethical responsibility		
4	The ability to communicate in a foreign language.				
5	Ability to assess and ensure the quality of of the work performed				
7	Ability to exercise your rights and responsibilities as a member of society; awareness of the value of civil (free democratic) society and the need for for its sustainable development, the rule of law, the rule of law, human and and freedoms in Ukraine.				
8	The ability to preserve and increase moral, cultural, scientific values and achievements of society based on an understanding of history and patterns of development of pharmacy, its place in the general system of knowledge about nature and society and in the development of of society, technology and technology, to use different types and forms of physical activity for active recreation and maintaining healthy lifestyle of life				
9	Ability to to use				

	information and communication technologies				

Learning outcomes:

Learning outcomes for a discipline are a set of knowledge, skills, abilities, and other forms of competences acquired by a person in the process of learning in accordance with the higher education standard,that can be identified, quantified and measured.

Programme learning outcomes:

PLO01. To have and apply specialised conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements.
PLO03. Have specialised knowledge and skills to solve professional problems and tasks, including professional problems and tasks, including for the purpose of further development of knowledge and procedures in the field of pharmacy.
PLO04. To communicate fluently in the state and English languages orally and in writing for to discuss professional problems and performance, present scientific research and innovation projects.
PLO07. Collect the necessary information on the development and production of medicines using professional literature, patents, databases and other sources; systematise, analyse and evaluate it, in particular, using statistical analysis.
PLO 10. Ensure the quality of pharmaceutical products, develop integrated quality systems at the pharmaceutical enterprise, taking into account provisions f international standards, pharmaceutical quality system and good manufacturing practice.
PLO15. Investigate the stability of active pharmaceutical ingredients and active pharmaceutical ingredients and medicinal products, establish shelf life and storage conditions,ensure proper storage conditions in production.
PLO20. To carry out pharmaceutical development of medicinal products of natural and synthetic origin in the conditions of industrial production**.**

Learning outcomes:

Integrative final programme learning outcomes, the formation of which to which the discipline contributes:
 Ability to interpret the biological properties of microorganisms, which is the basis for their use in biotechnological processes;
 Ability to determine the methods and means of biotechnological processes.
 Ability to plan and determine the sequence of stages of genetic engineering technologies.
 Ability to interpret the results of genetic engineering technologies, determine ways to optimize the conditions of biotechnological production.
Learning outcomes for a discipline - a set of knowledge, skills, abilities, other forms of competence acquired by a person in the process of learning in accordance with the of higher education that can be identified, quantified and measured**.**

According to higher education standards, students should:

Know

 biological properties of microorganisms, which are the basis for their use in biotechnological processes;
 identify methods and tools of biotechnological processes.

Be able to:

 plan and determine the sequence of stages of genetic engineering technologies and interpret the results

Structure elective course
“Microorganisms in biotechnological processes"

The distribution of study time by forms of study and types of classes according to the working curriculum is provided.

№	Topic	Lectures	Seminars study	SEW
1	Biotechnology as a new branch of science. History, subject and tasks of biotechnology.	2		
2	Stages of development of biotechnology as a science. Value for medicine and society.			2
3	Biology of microorganisms that are the basis for use in biotechnological processes. Microorganisms in genetic engineering technologies.	2		
4	Characterization of microorganisms as classical objects for use in biotechnological processes			4
5	Metabolism of bacteria: protein, hydrocarbon, lipid and mineral metabolism. Practical use of enzym properties of biotechnology of bacteria.			5
6	Principles of obtaining biologically active substances using biotechnological processes: vitamins, hormones, valuable organic compounds	2		
7	Features of the genetic apparatus of bacteria. Research methods.			5
8	Types of variability. Genetic recombination in bacteria. Classical and modern research methods.			4
9	Genetic variability: mutations and recombination. The essence, classification, manifestations of mutational variability.			4
10	Features of the genetic apparatus of of bacteria. Research methods		2	
11	Types of variability. Genetic recombination in bacteria. Classical and modern methods of research.		2	
12	Planning for genetic -engineering task task. The main tools of of biotechnology and genetic engineering			4
13	The regularities of of biotechnological processes, basic principles of regulation parameters of biotechnological processes.		2	
14	Design and selection of of recombinant DNA molecules		2	
15	Characteristics of the main microbiological industries (producers, raw materials, stages of the of the industrial process, use of of the finished product): ethanol, acetone, butanol, acetic and citric acids, amino acids, antibiotics.		2	4

16	Microorganisms -recombinants. Ways of to increase the efficiency of products of biologically active substances		2	
17	Genetically -modified microorganisms as producers of biologically active substances: hormones, interferons, vitamins, etc. Solving environmental problems and biotechnology of microorganisms.		2	
18	The concept of monoclonal antibodies. Hybridoma technologies.			4
19	Stages in the development of cellular biotechnology. Types of hybrid cells and methods of their production. Cell culture eukaryotes. Hybrid technology. is a vivid example of biotechnology into practice. .		2	4
20	Methods for the production of bioregulators and other biotechnological products for for use in medicine.	2	2	
21	Using of Bacteriophages in biotechnological processes.			4
22	The use of biotechnology for the manufacture of antibiotics. Requirements for microorganisms- producers of antibiotics			4
23	Fundamentals of biotechnology and genetic engineering in the production of vaccines of vaccine preparations.	2		
24	Characteristics of the main directions of vaccine for the prevention of COVID-19 infection and AIDS.	2		
25	Quality assessment of recombinant vaccines. Advantages over conventionally produced vaccines over conventionally produced vaccines.			4
26	DNA and RNA vaccines. Advantages over over traditional drugs.			4
27	Methods of producing vaccines through biotechnology. The main areas of vaccine production for prevention of coronavirus infection		2	
28	The use of biotechnology for for the production of probiotic drugs.			4

29	Prospects for the application of of biotechnology for the creation of food products.			4
30	Transgenic technologies. Problems of of biosafety.			4
	Total from the discipline	**10**	**20**	**60**

Syllabus of lectures

№ Item No.	**THEME**	**Q-ty hours**
1.	Biotechnology as a new branch of science. History, subject and tasks of biotechnology.	2
2.	Biology of microorganisms that are the basis for use in biotechnological processes. Microorganisms in genetic engineering technologies.	2
3.	Principles of obtaining biologically active substances using biotechnological processes: vitamins, hormones, valuable organic compounds	2
4.	Fundamentals of biotechnology and genetic engineering.	2
5.	Prospects for obtaining drugs for the prevention of HIV and COVID-19 infection	2
	TOTAL:	**10**

Thematic plan seminar lessons.

№ Item No.	**THEME**	**Q-ty hours**
1.	Features of the genetic apparatus of bacteria. Research methods.	2
2.	Types of variability. Genetic recombination in bacteria. Classical and modern research methods.	2
3.	Genetic engineering task planning. Basic tools of biotechnology and genetic engineering.	2
4.	Construction and selection of recombinant DNA molecules.	2
5.	Characteristics of the main microbiological productions (producers, raw materials, stages of the industrial process, use of the finished product): ethanol, acetone, butanol, acetic and citric acids, amino acids, antibiotics.	2
6.	Recombinant microorganisms. Ways to increase the efficiency of production of biologically active substances.	2
7.	Genetically modifying microorganisms as producers of new drugs. Biologically active substances and hormones in biotechnological production. Solution of ecological problems and biotechnology of	2

	microorganisms.	
8.	Stages of formation of cell engineering. Types of hybrid cells and methods of their production. Eukaryotic cell culture. Hybrid technology is a vivid example of biotechnology coming into practice.	2
9.	Methods of obtaining bioregulators and other biotechnological products for use in medicine.	2
10.	Methods of obtaining vaccines through the use of biotechnology. The main directions of obtaining vaccines for the prevention of coronavirus infection	**2**
	TOTAL:	**20**

Self Education Work

In accordance with the current provisions on the organization of the educational process,independent work of the student is one of the forms of the organization of training, the basic form of mastering of a training material in free time from obligatory training classes according to the schedule.

Self Education Work of university students regulated by the "Regulations on independent work of students of LNMU Danylo Halytskyi "dated 24.10.10, protocol №4.

Self Education Work of students (SEW) and its control

№	Topic	Hours
1.	Stages of development of biotechnology as a science. Value for medicine and society.	2
2.	Characterization of microorganisms as classical objects for use in biotechnological processes	4
3.	Metabolism of bacteria. Protein, hydrocarbon, lipid and mineral metabolism. Practical use of enzyal properties of bacteria.	5
4.	Organization of bacterial cell genetic material; bacterial chromosome, plasmids, migrating elements.	5
5.	Modification variability, its mechanisms and forms of manifestation in bacteria. Dissociation.	4
6.	Genetic variability. mutations and recombination. Essence, classification, manifestations.	4
7.	Regularities of biotechnological processes, basic principles of regulation of parameters of biotechnological processes.	4
8.	The concept of monoclonal antibodies. Hybridoma technologies.	4
9.	Bacteriophages in microbiology and medicine. Use in biotechnological processes.	4
10.	The use of biotechnology for the manufacture of antibiotics. Requirements for microorganisms-producers of antibiotics.	4
11.	Quality assessment of recombinant vaccines Advantages over vaccines obtained by the classical method.	4
12.	Characteristics of the main directions of vaccine for the prevention of COVID-19 infection.	4
13.	The use of biotechnology for the manufacture of probiotics.	4
14.	Prospects for the use of biotechnology to create food products.	4

15.	Transgenic technologies. Biosafety issues.	4
	Summary SEW	60

Individual educational and research task is one of the forms of organization of education at the university, which aims to deepen, generalize and consolidate the knowledge gained by students in the learning process, as well as the application of this knowledge in practice. Individual tasks are performed by students independently under the guidance of teachers.

The purpose of the individual educational and research task is independent study of a part of the program material, systematization, deepening, generalization and practical application of the student's knowledge from the educational course, development of skills of independent work. The designed individual task has a title page, the content of the individual task, theoretical and practical component, conclusion, list of references. Disclosure of an individual task should have a practical focus, connection with a specific object of activity in the field of medicine or dentistry. Registration of work is carried out according to requirements of regulatory (methodical) documents.

The section should reveal the forms of organization of individual tasks in the discipline and their topics. An individual educational and research task is performed if it is planned in the working curriculum for the academic year.

"Methods of study": relevance of the subject of the lesson, connection with related disciplines, practical skills, current control of students' preparation for the lesson with the use of test tasks of the license exam "Step-1", the use of interactive methods: "Brainstorming", "Competitive group method", "Case method" and other educational technologies used for the transfer and acquisition of knowledge, skills and abilities.

Section "Methods of control" should contain a statement of the content and technology of assessment of students' knowledge, namely - a list of all types of work that the student must perform during the current, final control, independent work, individual tasks and criteria for their assessment.

Distribution of grades received by students

The section indicates:

- **Types of control** (current and final)
- **Form of final control according to the curriculum**

(credit, exam **)**

Merit Review Criteria

Control measures include the current and final semester control and certification of graduates.

Current control carried out during training sessions

4-point Scale	**200 - point Scale**	**4 - point Scale**	**200 - point Scale**	**4 - point Scale**	**200 - point Scale**	**4 - point Scale**	**200 - point Scale**

and aims to test students' mastery of educational material.

Evaluation of current educational activities . During the assessment of learning each topic for the current educational activity of the student is graded on a 4-point (traditional) scale. This takes into account all types works provided by the curriculum. The student must receive a grade of each topic. Forms of assessment of current educational activities should be standardized and include control of theoretical and practical training.

Evaluation of student's Self Education Work.

The material for the independent work of students, which is provided in the topic of practical training simultaneously with classroom work, is evaluated during the current control of the topic at the appropriate classroom. Evaluation of topics that are submitted for independent study and are not included in the topics of classroom training sessions is carried out during the final control (exam).

For disciplines the form of final control which is a test:

Maximum number of points , which can be typed by a student for the current academic year activity in the study of the discipline is 200 points.

Minimum number of points , which must be typed by the student for the current educational activity for enrollment in the discipline is 120 points.
Calculation of the number of points conducted on the basis of received by the student (national) scale during the study of discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted into points on a multi-point scale as follows: =CA*200/5

For convenience, the table of recalculation on a 200-point scale is given:

Table 1

Recalculation of the average score for current activities in a multi-point scale for disciplines that end with a test

5	200	4.45	178	3.92	157	3.37	135
4.97	199	4.42	177	3.89	156	3.35	134
4.95	198	4.4	176	3.87	155	3.32	133
4.92	197	4.37	175	3.84	154	3.3	132
4.9	196	4.35	174	3.82	153	3.27.	131
4.87	195	4.32	173	3.79	152	3.25 3.22	130
4.85	194	4.3	172	3.77	151	3.2	129
4.82	193	4.27	171	3.74	150	3.17	128
4.8	192	4.24	170	3.72	149	3.15	127
4.77	191	4.22	169	3.7	148	3.12.	126
4.75	190	4.19	168	3.67	147	3.1	125
4.72	189	4.17	167	3.65	146	3.07	124
4.7	188	4.14	166	3.62	145	3.02	123
4.67	187	4.12	165	3.57	143	3	121
4.65	186	4.09	164	3.55	142	Less	120
4.62	185	4.07	163	3.52	141	3	Not
4.6	184	4.04	162	3.5	140		enough
4.57	183	4.02 3.99	161	3.47	139		
4.52	181	3.97	160	3.45	138		
4.5	180	3.94	159	3.42	137		
4.47	179		158	3.4	136		

List of questions for scoring

1. Stages of development of biotechnology as a science. Value for medicine and society.
2. Biology of microorganisms that are the basis for use in biotechnological processes. Microorganisms in genetic engineering technologies.
3. Bacterioscopic method of research. Stages.
4. Bacteriological method of research. Principles and methods of isolation of pure cultures of aerobic bacteria and their identification.
5. The use of microbes and their enzymes in biotechnology for the production of amino acids, peptides, organic acids, vitamins, hormones, antibiotics, feed protein, for food and industrial processing, biological wastewater treatment, liquid and gaseous fuels.
6. The structure of the genetic apparatus of bacteria (chromosome, plasmids, migrating elements).
7. Functional units of the bacterial genome. Structural and regulatory genes, transcription, translation, reduplication of genetic information in bacteria.
8. Genotype and phenotype in bacteria. Types of variability in bacteria (modification, genotypic). Mutations, their types.
9. Modification variability, its mechanisms and forms of manifestation in bacteria. Dissociation bacteria.
10. Genetic recombination in bacteria (transformation, transduction, conjugation).
11. Gene pool of bacterial population. Genetic maps of microorganisms. Directions of selection of microorganisms. Obtaining and using strains producing antibiotics, enzymes, hormones, vitamins.

12. Plasmids and other mobile genetic elements, their importance in the formation of pathogenic properties of bacteria - toxigenicity, drug resistance.
13. Genetic diagnostic methods: polymerase chain reaction, restriction analysis and other new molecular genetic methods.
14. Microbiological basis of genetic engineering (enzymes - restrictases, ligases, polymerases, revertases). Vectors, methods of their introduction. Practical use of genetic engineering methods.
15. The main stages of obtaining a recombinant strain of microorganisms. Name 3-4 examples of genetically engineered products used in medicine.
16. Importance of biotechnology for pharmaceutical science and industry (production of antibiotics, vitamins, hormones, proteins and other macromolecular compounds).
17. Monoclonal antibodies, their production and use in medical practice.
18. Bacteriophage, history of study. Structure, classification of phages by morphology. Virulent and moderate phages. Characteristics of productive interaction. Lysogeny and phage conversion. Practical use of bacteriophages.
19. Fundamentals of biotechnology and genetic engineering. Methods of manufacture, evaluation of efficiency and control.
20. Genetically engineered vaccines. The main directions of obtaining a vaccine for the prevention of COVID-19 infection.
21. The use of biotechnology for the manufacture of probiotics. Probiotics and prebiotics, their characteristics, mechanism of action.
22. Transgenic technologies. Cultivation conditions and rules of work with genetically modified microorganisms. Environmental protection from genetically modified microorganisms.

List of practical skills

1. Carry out microscopy of the drug using an immersion lens, make a conclusion about the morphological properties of the studied microorganisms.
2. Prepare a bacterial preparation, stain according to the Gram method, perform microscopy using an immersion lens, make a conclusion about the purity of the studied culture of microorganisms.
3. Describe the cultural properties of colonies of microorganisms that have grown on the surface of MPA Justify the next course of research to identify a pure culture.
4. To take into account the biochemical activity of the selected culture of bacteria, to identify it.
5. Know the principle of modern test systems for biochemical identification of microorganisms.
6. Evaluate the results of determining the sensitivity of pure culture of microorganisms to antibiotics by disco-diffusion method. Conclude.
7. Explain the essence of enzyme-linked immunosorbent assay, take into account ELISA.
8. Describe the stages of obtaining monoclonal antibodies.
9. Explain the mechanism of genotypic variability (mutations and recombination).
10. Explain the mechanisms and manifestations of modification variability.
11. Explain the essence of polymerase chain reaction and restriction analysis.
12. To take into account the results of microbiological research of various clinical material and microflora of the environment.

Recommended literature.

Mandatory.

1.Medical microbiology, virology and immunology=Медична мікробіологія, вірусологія та імунологія : a textbook for English-speaking students of higher medical schools: translation from ukr. Published / [T.V. Andrianova, V.V. Bobyr, V.V. Danyleichenko, ect.] ed. by V. P. Shyrobokov. Vinnytsia: Nova Knyha, 2019. - 744 p. : ill.
2.Medical microbiology, virology and immunology=Медична мікробіологія, вірусологія та імунологія : підручник / Тимків М.З., Корнійчук О.П., Павлій С.Й. [та ін.]. – Вінниця: Нова Книга, 2019. – 416 с.
3.Levinson W. Review of medical microbiology and immunology. McGraw-Hill Medical, 2017.–710
4.Murray P. R., Rosenthal, K. S., Pfaller, M. A. Medical microbiology. Elsevier Health Sciences. – 848
5. Atlas R. M. Principles of microbiology.-McGraw-Hill, Boston, Massachusetts, 2001

Additional literature

6.Microbiology and immunology on-line http://www.microbiologybook.org/

7. on-line microbiology note http://www.microbiologyinfo.com/
8.8enters for diseases control and prevention www.cdc.gov .
9. Spada. G. Walsh Directory of Approved Biopharmaceutical Products 1st Edition . – CRCPress, 2019. – 336 p.
10. C. Kokare PHARMACEUTICAL BIOTECHNOLOGY 1st Edition. – Nirali Prakashan, 2017. –274. 8. 1
11/Kayser O. & Warzecha H. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications 2nd Edition. — Wiley, 2012. — 658 p.
12Palmer T., Bonner P.L. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. 2 edition. – Woodhead Publishing; 2007. – 432p.