

Ministry of Health of Ukraine  
Poltava State Medical University

Department of microbiology, virology and immunology

**"AGREED"**

Guarantor of the academic and professional  
program "Dentistry"

\_\_\_\_\_Tetyana PETRUSHANKO

" \_\_\_\_\_ " \_\_\_\_\_ 20\_\_ year

**"APPROVED"**

Head of the Academic Council  
of the Medical Faculty No. 2

\_\_\_\_\_Denys KAPUSTYANSKY

Minutes from \_\_\_\_\_ 20\_\_ №\_\_

**SYLLABUS**  
**MICROBIOLOGY, VIROLOGY AND IMMUNOLOGY**

Compulsory academic discipline

level of higher education	the second (master's) level of higher education
branch of knowledge	22 "Health care"
specialty	221 "Dentistry"
educational qualification	master of dentistry
professional qualification	dentist
educational and professional program	221 "Dentistry"
form of education	Full-time
course(s) and semester(s) of study of the academic discipline	II year, III-IV semesters

**"APPROVED"**

at the meeting of the department  
microbiology, virology and immunology  
Head of the department \_\_\_\_\_ Halyna  
LOBAN

Minutes as of \_\_\_\_\_ 20\_\_ №\_\_

Poltava - 2023

### DATA ON TEACHERS WHO TEACH THE COURSE

Surname, first name, patronymic of teacher (teachers), scientific degree, academic title	Loban Galina Andriivna	doctor of medicine, professor	Head of the department
	Faustova Maria Oleksiivna	Doctor of Medicine, associate professor	Associate professor of HEI, head of the department
	Polyanska Valentina Pavlovna	Ph.D., docent	Docent of HEI
	Zvyagolska Iryna Mykolayivna	Ph.D., docent	Docent of HEI
	Fedorchenko Vira Ivanivna	Ph.D., docent	Docent of HEI
	Olga Valeryivna Hancha	Ph.D., docent	Docent of HEI
	Nelya Oleksandrivna Bobrova	Ph.D.	Teacher of HEI
	Yulia Viktorivna Chumak	-	Teacher of HEI
Teacher profile	<a href="https://micro-biology.pdmu.edu.ua/team">Page of the department's website with information about teachers</a> (https://micro-biology.pdmu.edu.ua/team)		
Contact phone number	+380532 52-77-45		
Email:	microbiology@pdmu.edu.ua		
Department page on the university website	https://micro-biology.pdmu.edu.ua/		

### MAIN CHARACTERISTICS OF THE EDUCATIONAL DISCIPLINE

#### Scope of the academic discipline

Number of credits / hours – 5 ECTS credits / 150 hours, of which:

Lectures (hours) – 30 hours.

Practical classes (hours) – 70 hours.

Independent work (hours). - 50 hours

The type of control is an exam.

### **Policy of educational discipline**

Educational discipline is based on the conscious and conscientious performance of higher education education applicants' responsibilities, compliance with the general rules and norms of behavior accepted in society.

Normative documents regulating the organization of the educational process at the department and at the university can be found at link (<https://www.PSMU.edu.ua/n-process/department-npr>).

It is mandatory to attend systematically all types of educational classes, which are held according to the schedule of the educational process in accordance with the working educational plans and the program of the discipline. Education applicants of higher education must come to classes on time, according to the schedule.

The language of the educational process is the state language, and for education applicants of the international faculty additionally English (determined according to the study agreement).

During practical and lecture classes in the discipline, applicants are prohibited from using textbooks, manuals, notes, mobile phones or other electronic means capable of transmitting materials.

Processing of unsatisfactory grades at the Department of Microbiology, Virology and Immunology begins 2 weeks before the end of the semester and is carried out exclusively in the event that the student has an average score of current success in the discipline below 3.0 by reaching the minimum score for admission to the exam. Upon completion of each content module in the discipline, education applicants of higher education must get a positive grade for the content module control, which provides for the completion of computer testing.

Education applicants have the right to participate in the program of non-formal and informal education in accordance with the Regulation "On nonformal and informal education of participants in the educational process of the PSMU (Order of the Principal No. 315-dated 19.05.2021)

According to the Regulation "On academic integrity of Education applicants and employees of PSMU" during their studies at the Department of Microbiology, Virology and Immunology, higher Education applicants have:

- independently perform educational tasks, tasks of current and final control of learning results;
- refer to sources of information in case of borrowing ideas, statements, information;
- comply with copyright legislation;
- provide reliable information about the results of one's own educational (scientific, creative) activities, used research methods and sources of information.

During their stay at the department, education applicants must:

- adhere to a business style of clothing;
- maintain order in classrooms;
- be careful with the property (furniture, equipment) located in the educational premises of the department;
- not take things and equipment out of the classrooms and laboratory of the department without the teacher's permission

**Entry of education applicants to the Department of Microbiology, Virology and Immunology without a medical uniform (gown and cap) is prohibited.**

### **Description of the academic discipline**

Microbiology, virology, and immunology is the discipline that contributes to the training of healthcare professionals. Graduates of higher education acquire theoretical knowledge and practical skills related to issues of general, special, sanitary microbiology, the basics of immunology, and general and special virology, which create prerequisites for successful diagnostics, treatment, and prevention of human infectious diseases.

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**Subject** the study of the academic discipline is the properties of the normal microbiota of the human body and its physiological functions; properties of pathogenic representatives of the world of microbes, their interaction with the human body; mechanisms of the development of infectious diseases, methods of their diagnostics, specific prevention and treatment.

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### **Pre-requisites and post-requisites of the academic discipline**

**Pre-requisites.** Study of the discipline "Microbiology, Virology and Immunology" of the second (master's) level of higher education in the specialty 221 "Dentistry" field of knowledge 22 Health care educational qualification "Master of Dentistry" is based on knowledge of the discipline of medical biology.

**Post-requisites.** Study of the discipline "Microbiology, Virology and Immunology" of the second (master's) level of higher education in the specialty 221 "Dentistry" in the field of knowledge 22 Health care educational qualification "Master of Dentistry" lays the foundations for the study of such disciplines as therapeutic dentistry, surgical dentistry and orthopedic dentistry.

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### **The purpose and tasks of the educational discipline:**

1.1. The purpose of the educational discipline is to study the properties of pathogenic representatives of the world of microbes, their interaction with the human body, the mechanisms of the development of infectious diseases, methods of their diagnostics, specific prevention and treatment, mastering by education applicants of higher education the necessary skills and abilities that correspond to the ultimate goals of studying the educational discipline.

1.2. The main tasks of studying the discipline are:

- Interpret the biological properties of pathogenic and non-pathogenic microorganisms, viruses and patterns of their interaction with the macroorganism, the human population, and the environment.
  - Determine the methods of microbiological and virological diagnostics, etiotropic therapy and specific prevention of infectious diseases.
  - Explain the structure of the immune system of the human body.
  - Interpret the main mechanisms of formation of the immune response of the human body.
  - Determine the main types of pathological reaction of the immune system and the connection with the occurrence of the most common human diseases.
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**Competencies and learning outcomes according to the educational and professional program, the formation of which is facilitated by the discipline**

*Competencies according to the educational and professional program, the formation of which contributes to the discipline*

*Table 1*

Integral competence	The ability to solve complex tasks and problems in the field of health care in the specialty "Stomatology" in professional activity or in the learning process, which involves conducting research and/or implementing innovations and is characterized by the uncertainty of conditions and requirements.
General competences (GC)	<ol style="list-style-type: none"> <li>1. Ability to abstract thinking, analysis and synthesis.</li> <li>2. Knowledge and understanding of the subject area and understanding of professional activity.</li> <li>3. Ability to apply knowledge in practical activities.</li> <li>4. Ability to search, process and analyze information from various sources.</li> <li>5. Ability to identify, determine and solve problems.</li> <li>6. Efforts to preserve the environment.</li> </ol>
Special (professional, subject) competences	<ol style="list-style-type: none"> <li>1. Ability to collect medical information about the patient and analyze clinical data.</li> <li>2. Ability to interpret the results of laboratory and instrumental research.</li> <li>3. Ability to diagnose: determine the preliminary, clinical, final, concomitant diagnostics, emergencies.</li> <li>4. Ability to plan and implement measures for the prevention of diseases of organs and tissues of the oral cavity and maxillofacial region.</li> <li>5. Ability to design the process of providing medical care: to determine the approaches, plan, types and principles of treatment of diseases of organs and tissues of the oral cavity and maxillofacial region.</li> <li>6. Ability to determine the rational mode of work, rest, diet in patients in the treatment of diseases of organs and tissues of the oral cavity and maxillofacial region.</li> <li>7. Ability to organize and conduct screening examinations in dentistry.</li> </ol>

*Program learning results according to the educational and professional program, the formation of which facilitated by the discipline*

1. Select and identify the leading clinical symptoms and syndromes (according to the list 1 Annex 1); according to standard methods, using preliminary data of the patient's anamnesis, data of the patient's examination, knowledge about the person, his organs and systems, to establish a probable nosological or syndromic preliminary clinical diagnostics of a dental disease.
2. Collect information about the general condition of the patient; assess the psychomotor and physical development of the patient, the condition of the maxillofacial organs, based on the results of laboratory and instrumental studies to assess information about the diagnostics.
3. Assign and analyze additional (mandatory and optional) examination methods (laboratory, radiological, functional and / or instrumental) according to list 5, patients with diseases of organs and tissues of the oral cavity and maxillofacial region for differential diagnostics of diseases.
4. Determine the final clinical diagnostics in accordance with the relevant ethical and legal norms, by making an informed decision and logical analysis of the obtained subjective and objective data of clinical, additional examination, differential diagnostics under the supervision of a doctor in a health care facility.
5. Plan and implement measures to prevent dental diseases among the population to prevent the spread of dental diseases.
6. Analyze the epidemiological situation and carry out measures of mass and individual, general and local drug and non-drug prevention of dental diseases.
7. Determine the approach, plan, type and principle of treatment of dental disease by making a reasonable decision according to existing algorithms and standard schemes.
8. To determine the tactics of managing a dental patient with somatic pathology by making an informed decision according to existing algorithms and standard schemes.
9. Carry out treatment of major dental diseases according to existing algorithms and standard schemes under the supervision of a physician-manager in a health care facility.
10. Assess the impact of the environment on the health of the population in a medical institution according to standard methods.
11. Adhere to a healthy lifestyle; use the techniques of self-regulation and self-control.
12. Adhere to the requirements of ethics, bioethics and deontology in their professional activities.
13. Organize the necessary level of individual safety (personal and **carers**) in case of typical dangerous situations in the individual field of activity.
14. Perform medical manipulations based on preliminary and / or final clinical diagnostics for different segments of the population and in different conditions.
15. Perform medical dental manipulations on the basis of preliminary and / or final clinical diagnostics for different segments of the population and in different conditions.
16. Perform emergency medical care manipulations using standard schemes, under any circumstances, based on a diagnostics of emergency in a limited time.

***Learning outcomes for the discipline:***

Have been completed the study of the academic discipline, applicants of higher education must **know:**

1. Leading clinical symptoms and syndromes of infectious diseases of maxillofacial localization.

2. Methods and rules for evaluating the results of laboratory studies.
3. Additional methods of examination (laboratory) of patients with diseases of organs and tissues of the oral cavity and maxillofacial localization for differential diagnostics of diseases.
4. Measures to prevent dental diseases among the population to prevent the spread of dental diseases.
5. Measures of mass and individual, general and local drug and non-drug prevention of dental diseases.
6. Rules for microbiological studies of biological fluids and secretions.
7. The influence of the environment on the state of health of the population in the conditions of a medical institution according to standard methods.
8. Rules of a healthy lifestyle, methods of self-regulation and self-control.
9. Requirements of ethics, bioethics and deontology in their professional activity.
10. Rules for the organization of the required level of individual safety (own and the persons they care about) in case of typical dangerous situations in the individual field of activity.

**be able:**

1. Master modern methods of microbiological research in infectious diseases of organs and tissues of the oral cavity and maxillofacial region;
2. Evaluate the results of laboratory and instrumental studies of patients with diseases of organs and tissues of the oral cavity and maxillofacial region.
3. Plan and implement measures to prevent dental diseases among the population to prevent the spread of dental diseases.
4. Analyze the epidemiological situation and carry out measures of mass and individual, general and local drug and non-drug prevention of dental diseases.
5. Assess the impact of the environment on the health of the population in a medical institution according to standard methods.
6. Adhere to a healthy lifestyle, use the techniques of self-regulation and self-control.
7. Adhere to the requirements of ethics, bioethics and deontology in their professional activities.
8. Organize the necessary level of individual safety (personal and carers) in case of typical dangerous situations in the individual field of activity.

**Thematic plan of lectures (by modules) with an indication of the main issues considered at the lecture**

*Table 2*

No	TITLE OF THE TOPIC	Number of hours
<b>Module 1. Microbiology, virology and immunology</b>		
1	<b>Morphology and structure of bacteria. Methods of microbiological research. Physiology of microorganisms.</b>  Basic forms and sizes of bacteria. The structure of the bacterial cell. Morphophysiological features of gram-positive and gram-negative bacteria. Chemical composition and functional significance of different structures of	2

	prokaryotes. Bacterial polymorphism. Properties of L-forms of bacteria. Original methods of microbiological research. Physiology of microorganisms.	
2	<p><b>Basics of asepsis and antiseptics. Chemotherapeutic medicaments. Antimicrobial medicaments. Principles of chemotherapy. Antibiotics.</b></p> <p>The concept of chemotherapeutic medicaments, chemotherapeutic index. Microbial antagonism, its mechanisms. Antibiotics, definition, biological role in nature. Principles of obtaining of antibiotics. Classifications of antibiotics. Methods for determining the sensitivity of bacteria to antibiotics. The use of chemotherapeutic medicaments in dental diseases: antibacterial, antifungal, antiviral. Complications of antibiotic therapy. Dysbacteriosis.</p>	2
3	<p><b>Infection and infectious process.</b></p> <p>Definition of "infection", "infectious process", "infectious disease". Conditions of occurrence of infectious process. The role of microorganisms in the infectious process. Obligatory-pathogenic, opportunistic, non-pathogenic microorganisms. Virulence. Factors of pathogenicity of microorganisms.</p> <p>Ways of penetration of pathogens into the body. The spread of microbes and their toxins in the body. Dynamics of infectious disease development. Forms of infections.</p>	2
4	<p><b>Immunity. The body's immune system. Factors of innate immunity.</b></p> <p>Immunity, types of immunity and forms of its manifestation. Factors of innate immunity. Factors of innate protection of the oral cavity. Phagocytosis, concept of opsonins. Classification of phagocytic cells. The main stages of phagocytosis. Methods of studying phagocytic activity.</p> <p>Humoral factors of innate immunity: complement system, lysines, interferons, leukins, antiviral inhibitors, lysozyme, etc. Methods of their determination. Mechanical, chemical and biological factors of innate immunity in the oral cavity. The structure of the immune system. Central and peripheral organs of the immune system. Immunocompetent cells. Surface markers and receptors of these cells. Cooperation between immunocompetent cells in the process of forming an immune response.</p>	2
5	<p><b>Immune reactions. Antigens, antibodies. Immunoprophylaxis and immunotherapy.</b></p> <p>Antigens. Antigenic structure of microorganisms. Antibodies, structure and functions of antibodies (immunoglobulins). Classes of immunoglobulins, their structure and properties. Immunoglobulins of saliva. The role of secretory immunoglobulins. Serological reactions. Mechanism of interaction of antigens and antibodies in serological reactions. The main components of serological reactions. Practical use of serological reactions: antigen identification, diagnostic detection of antibodies. Diagnostic immune sera, diagnostic antigens.</p>	2



	Active and passive immunoprophylaxis and immunotherapy. Modern classification of vaccines. Vaccine prophylaxis and vaccine therapy. Autovaccines. Sera: classification, principles of obtaining, purification and control of sera and immunoglobulins. Seroprophylaxis and serotherapy.	
6	<p><b>RNA-genomic viruses. General characteristics. Orthomyxoviruses. Paramyxoviruses.</b></p> <p>Orthomyxoviruses. General characteristics and classification. Human influenza viruses. Damage to the mucous membrane of the oral cavity under conditions of influenza. Methods of laboratory diagnostics of influenza. Paramyxoviruses (viruses of parainfluenza, measles, mumps, respiratory syncytial infection). The structure of virions. Epidemiology and pathogenesis of paramyxovirus infections. Biological properties. Pathogenesis of diseases. Laboratory diagnostics.</p>	2
7	<p><b>Retroviruses, general characteristics. Oncoviruses. Other RNA-containing viruses.</b></p> <p>Retroviruses. General characteristics. Classification. Human immunodeficiency virus (HIV). Morphology and chemical composition. Epidemiology and pathogenesis of HIV infection. Target cells in the human body. Mechanisms of development of immunodeficiency, AIDS - associated pathology (opportunistic infections and tumors). Damage to the mucous membrane of the oral cavity under the conditions of HIV infection. Laboratory diagnostics of HIV infection. Oncoviruses. Mechanisms of carcinogenesis. Rhabdovirus family. Rabies virus, biological properties. Pathogenesis of the disease. Laboratory diagnostics. Specific prevention of rabies. Filoviruses (family Filoviridae). Ebola and Marburg virus. Genus Rubiviruses. Rubella virus.</p>	2
8	<p><b>Hepatitis viruses. Prions.</b></p> <p>Hepatitis A virus. Epidemiology and pathogenesis of hepatitis A. Immunity. Approaches to specific prevention. Laboratory diagnostics of hepatitis A. Hepatitis B virus. Epidemiology and pathogenesis of hepatitis B. Persistence. Immunity. Laboratory diagnostics of hepatitis B. Specific prevention and treatment of hepatitis B. Other causative agents of hepatitis (C, D, E, G, TTV, SENV), their taxonomic position, properties. The possibility of the spread of hepatitis during the treatment of patients with a dental profile.</p> <p>Prions. Slow viral infections.</p>	2
9	<p><b>DNA-genomic viruses. General characteristics. Herpesviruses, other DNA-containing viruses.</b></p> <p>Herpesviruses. General characteristics and classification. Herpes viruses that are pathogenic for humans: herpes simplex viruses of type 1 and 2, varicella-shingles virus, cytomegalovirus, Epstein-Barr virus. Epidemiology and pathogenesis of</p>	2

	<p>diseases caused by herpesviruses. Immunity. Mechanism of the persistency of herpes viruses. Lesions of the mucous membrane of the oral cavity under conditions of herpes infection. Laboratory diagnostics, specific prevention and treatment of herpes infections.</p> <p>Adenoviruses. General characteristics and classification. Epidemiology and pathogenesis of diseases caused by adenoviruses. Immunity. Persistence, oncogenic serotypes of adenoviruses. Laboratory diagnostics, specific prevention and treatment of adenovirus infections. Smallpox virus. Families Papillomaviridae and Polyomaviridae.</p>	
10	<p><b>Pathogenic purulent cocci (staphylococci, streptococci, meningococci, gonococci).</b></p> <p>Classification. Biological properties of staphylococci, streptococci, neisseria. Pathogenicity factors. The role of staphylococci and streptococci in the development of human pathology; epidemiology and pathogenesis of infections caused by them. Epidemiology and pathogenesis of meningococcal diseases. Methods of microbiological diagnostics of meningococcal diseases and bacteremia. Epidemiology and pathogenesis of gonorrhea. Acute and chronic gonorrhea.</p> <p>Damage to the mucous membrane of the oral cavity under the conditions of gonococcal stomatitis.</p> <p>Methods of microbiological diagnostics of staphylococcal and streptococcal diseases, meningitis and gonorrhea.</p>	2
11	<p><b>Pathogenic enterobacteria (Escherichia and Salmonella).</b></p> <p>Classification and general characteristics of representatives of the Enterobacteriaceae family. The genus Escherichia, their main properties. Microbiological diagnostics of coli-enteritis. Salmonella genus. Salmonella as causative agents of generalized infections (typhoid and paratyphoid). Salmonella as the causative agents of salmonellosis (gastroenterocolitis, gastroenteritis). Peculiarities of epidemiology and pathogenesis of diseases. Genus Klebsiella. Characteristics and biological properties. Role in pathology. Microbiological diagnostics.</p>	2
12	<p><b>Agents of diphtheria and tuberculosis.</b></p> <p>The causative agent of diphtheria. Morphology. Cultural properties. Pathogenicity factors. Diphtheria toxin. Toxigenicity. Epidemiology, pathogenesis of diphtheria. Antitoxic immunity. Bacteriocarrierity. Tuberculosis mycobacteria, species, morphological, tinctorial, cultural, and antigenic properties. Epidemiology and pathogenesis of tuberculosis. Patterns of immunity, the role of cellular mechanisms under conditions of tuberculosis.</p>	2

	Microbiological diagnostics of tuberculosis. Prevention and treatment of tuberculosis. BCG vaccine.	
13	<b>Normal human microbiota, dysbiosis. Microbiocenosis and immunity of the oral cavity.</b>  The main representatives of the permanent microbiota of the oral cavity. Representatives of the temporary microflora of the oral cavity. Adhesion and colonization. Coaggregation. Methods of microbiological research used in dentistry. Dysbacteriosis. Anaerobic cocci of the genera: Peptococcus, Peptostreptococcus, Veillonella. A group of anaerobic gram-negative rods (bacteroids, fusobacteria).	2
14	<b>The role of microorganisms and the state of immunity in conditions of caries and periodontitis.</b>  Dental plaque, composition and mechanism of formation. Caries as an infection associated with the resident flora of dental plaque. Immunological bases of caries etiology and pathogenesis. Microbiota as a factor in periodontal diseases. Supragingival and subgingival dental plaques, their composition and significance in the development of the pathological process. Participation of oral microorganisms in the pathogenesis of periodontitis. Periodontogenic types of microorganisms. Involvement of the immune system in the development of periodontitis.	2
15	<b>The role of microorganisms in specific infectious lesions of the mucous membrane of the oral cavity and inflammatory processes of the maxillofacial area.</b>  Stomatitis, glossitis, cheilitis. The role of resident flora in the occurrence of nonspecific inflammatory lesions of the mucous membrane of the oral cavity. Immunological basis of etiology and pathogenesis of nonspecific inflammatory lesions. Fusospirochetosis (ulcerative-necrotic stomatitis by Vincent). Bacterial stomatitis. Damage of the mucous membrane of the oral cavity under the conditions of tuberculosis, leprosy, syphilis, actinomycosis. Viral stomatitis. Damage of the mucous membrane of the oral cavity under the conditions of HIV infection, measles, foot and mouth. Candidiasis of the mucous membrane of the oral cavity.	2
Together		30

**Thematic plan of practical classes by modules and content modules, specifying the basic issues, which are considered at the seminar class**

*Table 3*

No	TITLE OF THE TOPIC	Number of hours
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<b>Module 1. Microbiology, virology and immunology</b>		
Content module 1. General microbiology. Antibiotics. Infection. Immunity.		
1.	<p><b>Organization of a bacteriological laboratory. Aniline dyes. Simple methods of staining of microorganisms. Methods of microscopy.</b></p> <ol style="list-style-type: none"> <li>1. Subject and tasks of medical microbiology. Connection of medical microbiology with practical activity of the doctor.</li> <li>2. Microbiological laboratory, its structure and purpose. Organization of the workplace of a bacteriologist.</li> <li>3. Rules of work and safety in the microbiological laboratory.</li> <li>4. Preparations for microscopy, methods of their manufacture.</li> <li>5. Aniline dyes, their properties. Simple methods of staining of microorganisms.</li> <li>6. Methods of research of morphology of microorganisms (microscopy). Light microscopy using immersion lenses.</li> <li>7. Rules of microscopy in a light microscope with immersion lenses.</li> <li>8. Dark-field, phase-contrast, luminescent and other methods of microscopy. Electron microscopy (enlightenment, scanning).</li> <li>9. Methods of microscopy in the diagnostics of infectious diseases.</li> <li>10. Types of bacteriological laboratories.</li> </ol>	2
2.	<p><b>Morphology and structure of bacteria. Differential method of Gram staining of bacteria.</b></p> <ol style="list-style-type: none"> <li>1. Basic forms and sizes of bacteria.</li> <li>2. The structure of the bacterial cell. Flagella, cilia, capsule, cell wall, periplasm, cytoplasmic membrane, cytoplasm, nucleoid, plasmids, ribosomes, mesosomes, inclusions.</li> <li>3. Morphophysiological features of gram-positive and gram-negative bacteria.</li> <li>4. Chemical composition and functional significance of different structures of prokaryotes.</li> <li>5. Bacterial polymorphism. Subcellular forms of bacteria. Properties of L-forms of bacteria.</li> <li>6. Bacterial spores. Features of chemical composition and structure, function. The process of spore formation.</li> <li>7. Complex methods of staining microorganisms. Gram staining technique.</li> <li>8. Factors on which Gram staining of microorganisms depends.</li> <li>9. Properties of gram-positive and gram-negative microorganisms. The practical significance of the Gram staining method.</li> </ol>	2

	<p>10. Complex methods of staining: Ozheshko, Peshkov, Ziehl-Neelsen, Neisser, Leffler, Burry-Gins, Leffler (for flagella).</p> <p>11. Detection of bacterial motility. Preparation of smears "hanging" drop and "pressed" drop.</p> <p>12. The value of the bacterioscopic method in dental practice.</p>	
3	<p><b>Morphology and structure of spirochetes, actinomycetes, fungi and protozoa. Methods of studying their morphology.</b></p> <p>1. Spirochetes (treponema, borrelia, leptospira). Features of morphology and structure (membrane, fibrils, blepharoplast), mobility. Pathogenic representatives.</p> <p>2. Methods of studying the morphology and mobility of spirochetes.</p> <p>3. Actinomycetes, features of morphology. Methods of studying of the morphology of actinomycetes.</p> <p>4. The structure of the cell of fungi. Hyphae, mycelium. Features of the structure of the cytoplasmic membrane and cell wall.</p> <p>5. The main forms of fungi: yeast, yeast-like fungi, filamentous fungi. Dimorphism of fungi.</p> <p>6. Mechanisms of reproduction of fungi: budding, spore formation. Vegetative spores, endospores, sexual spores.</p> <p>7. Methods of studying the morphology of fungi.</p> <p>8. Features of the structure of protozoa: pellicle, endoplasm, ectoplasm, other organelles; cysts. Life cycles of the simplest, pathogenic for humans.</p> <p>9. Methods of studying the morphology of protozoa. Staining according to Romanovsky-Gimza.</p> <p>10. Spirochetes, actinomycetes, fungi and protozoa, which are part of the normal microflora of the oral cavity.</p> <p>11. Morphology and structure of other representatives of prokaryotes: rickettsiae, chlamydia, mycoplasmas.</p> <p>12. Classification of fungi and protozoa.</p>	2
4.	<p><b>Nutrient media for the cultivation of microorganisms. Sterilization. Growth and reproduction of microorganisms. Isolation of pure cultures of bacteria (1st session).</b></p> <p>1. Rules for working with bacterial cultures and safety in the bacteriological laboratory.</p>	2

	<p>2. Nutrition of microorganisms, classification by type of nutrition. Mechanisms of nutrient transfer into the bacterial cell.</p> <p>3. Cultivation of bacteria. Nutrient media, classification by purpose, consistency, origin and number of components.</p> <p>4. Sterilization. Sterilization methods, sterilization evaluation.</p> <p>5. Asepsis, antiseptics, disinfection.</p> <p>6. Bacteriological (cultural) method of diagnostics of infectious diseases.</p> <p>7. Growth and reproduction of microorganisms. Vegetative forms and dormant forms of microbes.</p> <p>8. Phases of reproduction of microbes in a liquid nutrient medium in stationary conditions.</p> <p>9. Mixed and pure cultures of bacteria. Isolation of pure cultures of aerobic bacteria (1st stage of the study).</p> <p>10. Colonies, features of their formation in different species of bacteria. Pigmentation.</p> <p>11 Isolation of pure cultures of aerobic bacteria (2nd stage of the study).</p> <p>12. Fermentative metabolism and its products</p>	
5.	<p><b>Growth and reproduction of microorganisms. Isolation of pure cultures of bacteria and their identification (2nd session).</b></p> <p>1. Enzymes of bacteria and their classification.</p> <p>2. Methods of studying the enzymatic activity of bacteria and using them to identify bacteria.</p> <p>3. Differential diagnostic nutrient media, their composition and purpose.</p> <p>4. Methods of identification of selected cultures. The concept of serovars, morphovars, biovars, phagovars.</p> <p>5. Modern methods of bacterial identification using automated enzyme identification systems.</p> <p>6. Isolation of pure aerobic cultures (3rd and 4th stages).</p>	2
6.	<p><b>Isolation of pure cultures of bacteria and their identification (3rd session).</b></p> <p>1. Respiration of microorganisms. Types of respiration.</p> <p>2. Methods of creation anaerobic conditions for culturing of bacteria.</p> <p>3. Nutrient media for the cultivation of anaerobes.</p> <p>Isolation of pure cultures of anaerobic bacteria (1-5 stages of the study).</p> <p>5. Features of cultivation of rickettsiae, chlamydia, spirochetes.</p>	2
7.	<b>Microbial antagonism. Antibiotics.</b>	2

	<ol style="list-style-type: none"> <li>1. The concept of chemotherapeutic medicaments, chemotherapeutic index.</li> <li>2. Microbial antagonism, its mechanisms. Antagonistic microbes are producers of antibiotics. The doctrine of I Mechnikov for the physiological role of lactic acid bacteria in the intestine.</li> <li>3. Antibiotics, definition, biological role in nature. Principles of obtaining of antibiotics.</li> <li>4. Classification of antibiotics by origin, chemical composition, mechanism and spectrum of antimicrobial action. Bactericidal and bacteriostatic action of antibiotics.</li> <li>5. Units of measurement of antimicrobial activity of antibiotics.</li> <li>6. Methods for determining the sensitivity of bacteria to antibiotics: the method of standard disks (antibioticogram), the method of serial dilutions. The concept of minimum inhibitory concentration.</li> <li>7. The use of chemotherapeutic medicaments in dental diseases: antibacterial, antifungal, antiviral.</li> <li>8. Complications of antibiotic therapy. Dysbacteriosis. Antibiotic-resistant, antibiotic-dependent and tolerant strains of bacteria.</li> <li>9. Natural and acquired resistance of microorganisms to antibiotics. Genetic and biochemical mechanisms of antibiotic resistance. The role of plasmids and transposons in the formation of drug resistance in bacteria.</li> <li>10. Ways to prevent the formation of bacterial resistance to antibiotics. Principles of rational antibiotic therapy.</li> <li>11. Intercellular communication in bacteria ("sense of quorum") and prospects for the creation of a new generation of antimicrobial medicaments based on it.</li> <li>12. Antiviral medicaments. Mechanism of action.</li> </ol>	
8.	<p><b>The infectious process, its types, conditions of occurrence and development.</b></p> <ol style="list-style-type: none"> <li>11. Definition of "infection", "infectious process", "infectious disease". Conditions of occurrence of infectious process.</li> <li>2. The role of microorganisms in the infectious process. Pathogenicity of microbes, determination. Obligatory-pathogenic, opportunistic, non-pathogenic microorganisms.</li> <li>4. Virulence, definition, units of measurement.</li> <li>5. Factors of pathogenicity of microorganisms</li> <li>7. Ways of penetration of pathogens into the body.</li> <li>8. The spreading of microbes and their toxins in the body: bacteremia, toxemia, sepsis and its consequences. Bacteriocarierity. Asymptomatic infection.</li> <li>9. Dynamics of infectious disease - periods of incubation, prodromal, exacerbation, ending (convalescence, recovery).</li> </ol>	2

	<p>10. Forms of infections.</p> <p>11. Mechanisms of infection transmission. The concept of pathogenesis of infectious diseases.</p> <p>12. Biological research method. Its use in the study of etiology, pathogenesis, immunogenesis, diagnostics, therapy and prevention of infectious diseases.</p>	
9.	<p><b>Morphology and structure of viruses. Virus cultivation methods. Definition of viral reproduction.</b></p> <p>1. Kingdom of viruses. Definition of viruses as special forms of living organization. Principles of structural organization of viruses.</p> <p>2. Virion and its components. Nucleocapsid, capsid, capsomeres, supercapsids (peplos), peplomers. Simple and complex viruses, types of symmetry of nucleocapsids.</p> <p>3. Chemical composition of viruses: nucleic acids, proteins, lipids, polysaccharides. Their features and functions. Virus enzymes, their role, classification.</p> <p>4. Reproduction of viruses in the process of their interaction with the cell. The main stages of interaction of viruses with cells in productive infection.</p> <p>5. Integrative and abortive types of interaction of viruses with the host cell. Persistence of the virus in cells. Virus interference, defective interfering particles. Satellite viruses.</p> <p>6. The importance of medical virology in the activities of a doctor. Features of the organization and activity of virological laboratories.</p> <p>7. Methods of culturing viruses in cells, in chicken embryos, in the body of laboratory animals. Classification of cell cultures used in virology, their characteristics.</p> <p>8. Methods of detection (indication) of viral reproduction by cytopathogenic action, plaque formation under agar and bentonite coating, viral inclusions, by hemagglutination reaction (HA) and hemadsorption (HAads).</p> <p>9. Methods of quantitative determination (titration) of viruses.</p> <p>10. Genetic methods for determining viruses and their nucleic components.</p> <p>11. Mechanisms of virus persistence.</p>	2
10.	<p>1. Immunity as a way to protect the body, which have signs of genetic alienation and are implemented by a specialized immune system. Types of immunity and forms of its manifestation.</p> <p>2. Factors of nonspecific protection of the organism from microorganisms. Nonspecific factors of oral protection.</p> <p>3. Barrier and antimicrobial properties of the skin, mucous membranes. Normal microflora. Areactivity of cells and tissues.</p> <p>4. Phagocytosis, the concept of opsonins. Classification of phagocytic cells. The main stages of phagocytosis. Completed and incomplete phagocytosis.</p> <p>5. The importance of phagocytosis in the implementation of natural immunity and in the development of the immune response. Methods of studying of phagocytic activity: phagocytic index, phagocytic activity.</p> <p>6. Humoral factors of nonspecific protection: complement system, lysines,</p>	2



	<p>interferons, leukins, antiviral inhibitors, lysozyme, etc. Methods of their investigation.</p> <p>7. Mechanical, chemical and biological factors of nonspecific resistance in the oral cavity (saliva and oral fluid, normal microflora, lysozyme, other salivary enzymes, complement, <math>\beta</math>-lysine, etc.). Features of phagocytosis in the oral cavity.</p> <p>8. The structure of the immune system. Central and peripheral organs of the immune system.</p> <p>9. Immunocompetent cells. Surface markers and receptors of these cells.</p> <p>10. Cooperation between immunocompetent cells in the process of forming an immune response.</p>	
11.	<p><b>Antigens and antibodies. Serological reactions.</b></p> <p>1. Antigens as inducers of the immune response. Structure of antigens, classification.</p> <p>2. Antigenic structure of microorganisms. Localization, chemical composition and specificity of antigens of bacteria, viruses, enzymes, toxins. The role of microbial antigens in the infectious process and the development of the immune response.</p> <p>3. Antibodies as a product of the humoral immune response. Structure and functions of antibodies (immunoglobulins). The concept of valence of antibodies.</p> <p>4. Classes of immunoglobulins, their structure and properties.</p> <p>5. Antigenic structure of immunoglobulins: iso-, allo-, idiotypic determinants. Practical use.</p> <p>6. Immunoglobulins of saliva. The role of secretory immunoglobulins.</p> <p>7. Serological reactions. The mechanism of interaction of antigens and antibodies in serological reactions. The main components of serological reactions.</p> <p>8. Practical use of serological reactions: antigen identification, diagnostic detection of antibodies. Diagnostic immune sera, diagnosticum.</p> <p>9. The use of serological reactions for the diagnostics of infectious diseases during a specific process in the oral cavity (syphilis, gonorrhea, diphtheria, herpes infection, etc.).</p> <p>10. Phenomena of detection and methods of registration of serological reactions. Reactions based on the phenomenon of agglutination: direct and indirect agglutination, reverse hemagglutination reaction. Practical use.</p> <p>11. Reactions based on the phenomenon of precipitation: ring precipitation, flocculation, gel precipitation. Practical use.</p> <p>12. Neutralization reaction (toxins, viruses, rickettsiae). Practical use.</p> <p>13. Immune lysis reaction (bacteriolysis, spirochetolysis, hemolysis).</p>	2

	<p>14. Complement binding reaction. Practical use.</p> <p>15. Human histocompatibility antigens and their importance in the immune response.</p>	
12.	<p><b>Serological reactions with labeled antibodies.</b></p> <ol style="list-style-type: none"> <li>1. Forms and types of immune response.</li> <li>2. Humoral immune response and its stages. Primary and secondary immune response.</li> <li>3. Interaction of cells of the immune system in the process of immune response. Participation of macrophages, T- and B-cells. Interleukins.</li> <li>4. Cellular immune response and its stages. Cytokines and their role in the formation of cellular immune response.</li> <li>5. Characteristics of the manifestations of the immune response.</li> <li>6. Mechanisms of formation of specific immunity of the oral cavity.</li> <li>7. Reactions using labeled antigens and antibodies.</li> <li>8. Fluorescent antibody test (FAT): direct and indirect.</li> <li>9. Enzyme-linked immunosorbent assay (ELISA): direct, indirect, solid-phase, competitive.</li> <li>10. Radioimmune analysis (RIA): competitive, reverse, indirect.</li> <li>11. Immunoelectron microscopy. Immunoblotting.</li> <li>12. Practical use of fluorescent antibody test (FAT): enzyme-linked immunosorbent assay and radioimmunoassay.</li> <li>13. Genetic research methods: PCR, DNA probe method, molecular hybridization.</li> </ol>	2
13.	<p><b>Vaccines and immune sera.</b></p> <ol style="list-style-type: none"> <li>1. Active and passive immunoprophylaxis and immunotherapy.</li> <li>2. Modern classification of vaccines: live, inactivated, chemical, toxoids, genetically engineered, synthetic, anti-idiotypic, DNA vaccines.</li> <li>3. Methods of manufacturing, evaluating the effectiveness and control of vaccines.</li> <li>4. Associated vaccines. Adjuvants.</li> <li>5. Vaccine prophylaxis and vaccine therapy. Autovaccines.</li> <li>6. Contraindications and complications observed in vaccine prophylaxis and vaccine therapy. Prevention of complications.</li> <li>7. Serum: classification, principles of production, purification and control of serum and immunoglobulins.</li> <li>8. Seroprophylaxis and serotherapy. Genetically engineered vaccines. Methods of manufacture, evaluation of efficiency and control.</li> <li>9. Complications during serotherapy and seroprophylaxis. Prevention of complications.</li> </ol>	2

14.	Computer test control for content module 1. *  Test tasks for KTI on the subject	2
Content module 2.Special virology.		
15.	<b>Orthomyxoviruses and paramyxoviruses. Laboratory diagnostics of influenza.</b> <ol style="list-style-type: none"> <li>1. Orthomyxoviruses. General characteristics and classification.</li> <li>2. Human influenza viruses. The structure of the virion. Features of the genome. Cultivation. Sensitivity to physical and chemical factors.</li> <li>3. Characteristics of human influenza virus antigens. Hemagglutinins, neuraminidases, functional activity. Classification of human influenza viruses. Types of antigenic variability, its mechanisms.</li> <li>4. Epidemiology and pathogenesis of influenza. Immunity.</li> <li>5. Lesions of the oral mucosa under influenza.</li> <li>6. Methods of laboratory diagnostics of influenza.</li> <li>7. Specific prevention and treatment of influenza.</li> <li>8. General characteristics and classification of paramyxoviruses.</li> <li>9. Paramyxoviruses (viruses of parainfluenza, measles, mumps, respiratory syncytial infection). The structure of virions. Antigens.</li> <li>10. Epidemiology and pathogenesis of paramyxoviral infections.</li> <li>11. Lesions of the oral mucosa under the conditions of measles.</li> <li>12. Immunity in paramyxovirus infections. Persistence of paramyxoviruses.</li> <li>13. Methods of laboratory diagnostics of paramyxoviral infections.</li> <li>14. Specific prevention and treatment of paramyxoviral infections.</li> <li>15. Human coronaviruses: SARS, MERS. Biological properties. Pathogenesis of diseases. Laboratory diagnostics.</li> </ol>	2
16.	<b>Picornaviruses. Laboratory diagnostics of enterovirus infections.</b> <ol style="list-style-type: none"> <li>1. Picornaviruses. General characteristics and classification of the family. Division into genera.</li> <li>2. Genus of enteroviruses. Classification: polio viruses, Coxsackie, ECHO. Characteristics of virions. Antigens. Cultivation.</li> <li>3. The role of enteroviruses in human pathology. Epidemiology, pathogenesis of polio and other enterovirus infections. Immunity.</li> <li>4. Lesions of the oral mucosa in sore throat caused by Coxsackie virus group A.</li> <li>5. Laboratory diagnostics of enteroviral infections.</li> <li>6. Specific prevention and treatment of enteroviral infections.</li> </ol>	2
17.	<b>Retroviruses. HIV. Laboratory diagnostics of HIV infection</b> <ol style="list-style-type: none"> <li>1. Retroviruses. General characteristics. Classification.</li> <li>2. Human immunodeficiency virus (HIV). Morphology and chemical composition.</li> <li>3. Features of the HIV genome. Variability, its mechanisms. Types of HIV.</li> </ol>	2

	<ul style="list-style-type: none"> <li>4. Stages of HIV interaction with sensitive cells.</li> <li>5. Sensitivity of HIV to physical and chemical factors.</li> <li>6. Epidemiology and pathogenesis of HIV infection. Target cells in the human body.</li> <li>7. Mechanisms of immunodeficiency development, AIDS - associated pathology (opportunistic infections and tumors).</li> <li>8. Lesions of the oral mucosa under conditions of HIV infection.</li> <li>9. Laboratory diagnostics of HIV infection.</li> <li>10. Treatment (etiotropic, immunomodulatory, immunosuppressive agents) of HIV infection. Prospects for specific HIV prevention.</li> <li>11. AIDS prevention in dentistry.</li> </ul>	
18.	<p><b>Pathogens of viral hepatitis. Laboratory diagnostics of hepatitis.</b></p> <ul style="list-style-type: none"> <li>1. Hepatitis A virus. Virion structure. Sensitivity to physical and chemical factors.</li> <li>2. Epidemiology and pathogenesis of hepatitis A. Immunity. Approaches to specific prevention.</li> <li>3. Laboratory diagnostics of hepatitis A.</li> <li>4. Hepatitis B virus. Virion structure. Sensitivity to physical and chemical factors.</li> <li>5. Antigens: HBs is the surface antigen of Dane particles. Internal antigens: HBs, HBe, their characteristics.</li> <li>6. Epidemiology and pathogenesis of hepatitis B. Persistence. Immunity.</li> <li>7. Laboratory diagnostics of hepatitis B. Methods of detection and diagnostic value of markers of hepatitis B (antigens, antibodies, nucleic acids).</li> <li>8. Specific prevention and treatment of hepatitis B.</li> <li>9. Other pathogens of hepatitis (C, D, E, F, G, TTV, SENV), their taxonomic position, properties.</li> <li>10. The role of hepatitis C, D, E, F, G, TTV, SENV viruses in human pathology.</li> <li>11. The possibility of the spread of hepatitis in the treatment of dental patients.</li> <li>12. Methods of laboratory diagnostics of hepatitis caused by viruses C, D, E, F, G, TTV, SENV.</li> <li>13. Prions. Slow viral infections.</li> </ul>	2
19.	<p><b>Herpesviruses and adenoviruses. Laboratory diagnostics of herpes and adenovirus infections.</b></p> <ul style="list-style-type: none"> <li>1. Herpesviruses. General characteristics and classification. Structure of virions, antigens, their localization and specificity, cultivation, sensitivity of vibrios to physical and chemical factors.</li> <li>2. Herpes viruses pathogenic to humans: herpes simplex viruses type 1 and 2, chickenpox virus - shingles, cytomegalovirus, Epstein-Barr virus. Epidemiology and pathogenesis of diseases caused by herpesviruses. Immunity. The mechanism of persistence of herpes viruses.</li> <li>3. Lesions of the oral mucosa under the conditions of herpes infection.</li> </ul>	2

	<p>4. Laboratory diagnostics, specific prevention and treatment of herpes infections.</p> <p>5. Adenoviruses. General characteristics and classification. Structure of virions, antigens, their localization and specificity, cultivation, sensitivity of vibrios to physical and chemical factors.</p> <p>6. Epidemiology and pathogenesis of diseases caused by adenoviruses. Immunity. Persistence, oncogenic serotypes of adenoviruses</p> <p>7. Laboratory diagnostics, specific prevention and treatment of adenoviral infections</p>	
20.	<p>Computer test control for content module 2. *</p> <p>Test tasks for CTE on the subject</p>	2
Content module 3. Pathogenic prokaryotes and eukaryotes.		
21.	<p><b>Staphylococci and streptococci. Microbiological diagnostics of diseases caused by staphylococci and streptococci.</b></p> <p>1. Evolution of the coccal group of bacteria, their general characteristics.</p> <p>2. Classification. Biological properties of staphylococci and streptococci. Pathogenic factors of staphylococci and streptococci.</p> <p>3. The role of staphylococci and streptococci in the development of human pathology; epidemiology and pathogenesis of infections caused by them.</p> <p>4. Etiological and pathogenetic role of group A streptococci in erysipelas, scarlet fever and rheumatism. Scarlet fever stomatitis.</p> <p>5. Odontogenic inflammatory process caused by staphylococci and streptococci; odontogenic sepsis; the role of streptococci in the etiology and pathogenesis of caries.</p> <p>6. Immunity and its features in conditions of staphylococcal and streptococcal infection.</p> <p>7. Prevention and treatment of staphylococcal and streptococcal infections. Preparations for specific prevention and therapy.</p> <p>8. Methods of microbiological diagnostics of staphylococcal and streptococcal diseases.</p>	2
22.	<p><b>Meningococci and gonococci. Microbiological diagnostics of diseases caused by meningococci and gonococci.</b></p> <p>1. The genus Neisseria. Biological properties. Classification. Neisseria - representatives of the permanent microflora of the oral cavity.</p> <p>2. Meningococci. Biological properties, classification. Factors of pathogenicity of meningococci.</p> <p>3. Epidemiology and pathogenesis of meningococcal diseases.</p> <p>4. Methods of microbiological diagnostics of meningococcal diseases and bacteriocarriers. Differentiation of meningococci and gram-negative diplococci of the nasopharynx.</p> <p>5. Prevention of meningococcal infection.</p> <p>6. Gonococci. Biological properties. Pathogenicity for humans, variability.</p>	2

	<ul style="list-style-type: none"> <li>7. Epidemiology and pathogenesis of gonorrhea. Acute and chronic gonorrhea.</li> <li>8. Lesions of the oral mucosa in gonococcal stomatitis.</li> <li>9. Immunity in gonorrhea.</li> <li>10. Methods of microbiological diagnostics of gonorrhea</li> <li>11. Prevention and specific therapy of gonorrhea, blenorrhea.</li> </ul>	
23.	<p><b>Escherichia coli and Salmonella. Microbiological diagnostics of colienteritis, typhoid fever, paratyphoid fever A and B, salmonella gastroenteritis.</b></p> <ul style="list-style-type: none"> <li>1. Classification and general characteristics of members of the family Enterobacteriaceae.</li> <li>2. The genus of Escherichia, their main properties. Classification by antigenic structure.</li> <li>3. Conditionally pathogenic and pathogenic enterobacteria. Classification of diarrheal Escherichia coli.</li> <li>4. Microbiological diagnostics of coli enteritis</li> <li>5. The genus Salmonella. General characteristics of the genus. Classification by biochemical characteristics and antigenic structure (Kaufman-White).</li> <li>6. Salmonella - pathogens of generalized infections (typhoid fever and paratyphoid fevers). Epidemiology, pathogenesis and immunogenesis of the diseases. Bacteriocarriers. Specific prevention and treatment.</li> <li>7. Salmonella - the causative agents of salmonellosis (gastroenterocolitis, gastroenteritis). Features of epidemiology and pathogenesis of diseases.</li> <li>8. Microbiological diagnostics of salmonellosis.</li> <li>9. Genus Klebsiella. Characteristics and biological properties. Klebsiella pneumonia, ozena and rhinoscleroma. Role in pathology. Microbiological diagnostics.</li> </ul>	2
24	<p><b>Shigella and vibrios. Microbiological diagnostics of shigellosis and cholera.</b></p> <ul style="list-style-type: none"> <li>1. The genus Shigella. Biological properties. Classification. Shigella virulence factors.</li> <li>2. Epidemiology, pathogenesis of shigellosis (dysentery). Immunity</li> <li>3. Methods of microbiological diagnostics of shigellosis.</li> <li>4. Specific prevention and treatment of shigellosis.</li> <li>5. Vibrio cholerae. Biovars classical and El-Tor, their differentiation. Classification of Vibrios by Heiberg. Antigenic structure, virulence factors of Vibrio cholerae. Cholero-gen, mechanism of action.</li> <li>6. Epidemiology, pathogenesis, main clinical manifestations of cholera. Immunity.</li> <li>7. Methods of microbiological diagnostics of cholera.</li> </ul>	2
25.	<p><b>Pathogens of plague and anthrax. Microbiological diagnostics of plague and anthrax.</b></p> <ul style="list-style-type: none"> <li>1. The causative agent of anthrax. Biological properties. Resistance. Pathogenicity factors, toxins. Pathogenicity to humans and animals.</li> <li>2. Epidemiology, pathogenesis of anthrax in humans.</li> </ul>	2

	<ul style="list-style-type: none"> <li>3. Lesions of the face and neck caused by anthrax.</li> <li>4. Immunity under anthrax.</li> <li>5. Methods of microbiological diagnostics of anthrax.</li> <li>6. The causative agent of plague. Biological properties. Virulence factors.</li> <li>7. Epidemiology, pathogenesis and clinical forms of plague.</li> <li>8. Immunity in plague.</li> <li>9. Methods of microbiological diagnostics of plague. Criteria for identification of the causative agent of plague.</li> <li>10. Specific prevention and treatment of anthrax and plague.</li> </ul>	
26.	<p><b>Corynebacteria. Microbiological diagnostics of diphtheria.</b></p> <ul style="list-style-type: none"> <li>1. The causative agent of diphtheria. Morphology. Cultural properties. Biovars. Resistance.</li> <li>2. Pathogenicity factors. Diphtheria toxin. Toxicity as a result of phage conversion. Molecular mechanism of action of diphtheria toxin.</li> <li>3. Epidemiology, pathogenesis of diphtheria.</li> <li>4. Antitoxic immunity. Bacteriocarriers.</li> <li>5. Diphtheroids representatives of the permanent microflora of the oral cavity.</li> <li>6. Diphtheria stomatitis.</li> <li>7. Microbiological diagnostics of diphtheria. Immunological and genetic methods for determining the toxigenicity of the diphtheria pathogen. Differentiation of diphtheria pathogen from other pathogenic and non-pathogenic corynebacteria for humans, toxigenicity control.</li> <li>8. Specific prevention and treatment of diphtheria.</li> <li>9. Bordetellas, their properties. The causative agent of pertussis, morphological, cultural, antigenic properties. Microbiological diagnostics and specific prevention of pertussis.</li> </ul>	2
27.	<p><b>Mycobacteria. Microbiological diagnostics of tuberculosis.</b></p> <ul style="list-style-type: none"> <li>1. Pathogenic, opportunistic and saprophytic mycobacteria.</li> <li>2. Mycobacteria of tuberculosis, species, morphological, tinctorial, cultural and antigenic properties.</li> <li>3. Variability of tuberculosis bacteria, pathogenicity factors. Tuberculin.</li> <li>4. Epidemiology and pathogenesis of tuberculosis.</li> <li>5. Primary tuberculosis of the lips and oral mucosa.</li> <li>6. Secondary tuberculosis of the oral mucosa: tuberculous lupus, miliary ulcerative and colliquative tuberculosis.</li> <li>7. Patterns of immunity, the role of cellular mechanisms in tuberculosis.</li> <li>8. Pathogens of mycobacteriosis. Classification, properties. Role in human pathology. Mycobacteriosis as a manifestation of HIV infection.</li> <li>9. Microbiological diagnostics of tuberculosis. Material for research.</li> <li>10. Prevention and treatment of tuberculosis. BCG vaccine. Antimicrobial medicaments, The problem of multiple resistance of Mycobacterium tuberculosis to chemotherapeutic medicaments.</li> <li>11. Mycobacteria of leprosy. Actinomycetes. Nocardia.</li> </ul>	2

28.	<b>Pathogens of anaerobic infections. Microbiological diagnostics of anaerobic infections (tetanus, botulism, gas gangrene).</b> <ol style="list-style-type: none"> <li>1. The genus Clostridia. Classification. Ecology, properties. Resistance to environmental factors.</li> <li>2. Toxigenicity of clostridia. Genetic control of toxin production.</li> <li>3. Clostridial causative agents of anaerobic wound infection. Species. Properties. Pathogenicity factors, toxins.</li> <li>4. Epidemiology, pathogenesis of anaerobic wound infection. Antitoxic immunity.</li> <li>5. Clostridia - representatives of the temporary microflora of the oral cavity.</li> <li>6. Anaerobic wound infection in a dental clinic.</li> <li>7. Clostridium tetanus and botulism. Properties. Pathogenicity factors, toxins.</li> <li>8. Epidemiology, pathogenesis of tetanus and botulism. Immunity.</li> <li>9. Microbiological diagnostics of anaerobic infection of wounds, tetanus and botulism.</li> <li>10. Specific treatment and prevention of anaerobic infection of wounds, tetanus and botulism.</li> </ol>	2
29.	<b>Spirochetes Microbiological diagnostics of syphilis, typhus and leptospirosis.</b> <ol style="list-style-type: none"> <li>1. General characteristics of the spirochete family. Classification.</li> <li>2. Spirochetes as representatives of the permanent microflora of the oral cavity.</li> <li>3. Genus Treponema. The causative agent of syphilis. Morphology, cultural properties.</li> <li>4. Epidemiology, pathogenesis and immunogenesis of syphilis.</li> <li>5. Microbiological diagnostics of syphilis.</li> <li>6. Prevention and treatment of syphilis.</li> <li>9. Occupational risk of infection for the dentist when communicating with patients with syphilis.</li> <li>7. Genus Borrelia. Pathogens of typhoid fever, epidemiology, pathogenesis, immunity. Specific prevention.</li> <li>8. Microbiological diagnostics of recurrent typhus.</li> <li>9. Lyme disease, pathogen, diagnostics, prevention.</li> <li>10. Genus Leptospira. Classification. Pathogens of leptospirosis, epidemiology, pathogenesis, immunity. Specific prevention and treatment.</li> <li>11. Microbiological diagnostics of leptospirosis.</li> <li>12. Campylobacter. Helicobacter pylori.</li> </ol>	2
30.	<b>Oral microflora.</b> <ol style="list-style-type: none"> <li>1. The main representatives of the permanent microflora of the oral cavity: aerobic, facultative anaerobic and obligate anaerobic microorganisms.</li> <li>2. Representatives of the temporary microflora of the oral cavity.</li> <li>3. Factors influencing the formation of the oral microflora.</li> </ol>	2



	<p>4. Mechanisms of formation of normal microflora. Adhesion and colonization. Coaggregation.</p> <p>5. Microbial colonization of various parts of the oral cavity.</p> <p>6. Changes in the microflora depending on age, human health and other factors.</p> <p>7. Methods of microbiological research used in dentistry.</p> <p>8. Malfunction in the microflora of the oral cavity. Dysbacteriosis.</p> <p>9. Anaerobic cocci of the genera: Peptococcus, Peptostreptococcus, Veillonella. Group of anaerobic gram-negative rods (bacteroids, fusobacteria).</p>	
31.	<p><b>Microbiological and immunological aspects of etiology and pathogenesis of caries.</b></p> <p>1. Features of oral diseases caused by resident microflora.</p> <p>2. Dental plaque, composition and mechanism of formation.</p> <p>3. Caries as an infection associated with the resident flora of dental plaque.</p> <p>4. Immunological bases of etiology and pathogenesis of caries.</p> <p>5. Microbial flora under conditions of acute and chronic pulpitis.</p> <p>6. Microbial flora under conditions of acute and chronic periodontitis.</p> <p>7. Dental inflammatory processes (periostitis, osteomyelitis, abscess, phlegmon), changes in the symbiosis of oral microorganisms under conditions of endogenous infections.</p> <p>8. Features of the study of material under conditions of caries, pulpitis and periodontitis.</p> <p>9. Rules for sampling material for the isolation of anaerobic bacteria.</p> <p>10. Anticariogenic vaccination</p>	2
32.	<p><b>Microbiological and immunological aspects of etiology and pathogenesis of periodontal lesions.</b></p> <p>1. Microflora as a factor in the occurrence of periodontal disease.</p> <p>2. Supragingival and subgingival dental plaques, their composition and importance in the development of the pathological process.</p> <p>3. Involvement of oral microorganisms in the pathogenesis of periodontitis.</p> <p>4. Periodontal species of microorganisms.</p> <p>5. Involvement of the immune system in the development of periodontitis.</p> <p>6. Nonspecific resistance of the organism under the conditions of periodontal diseases.</p>	2
33.	<p><b>Microbiological and immunological aspects of etiology and pathogenesis of lesions of the oral mucosa.</b></p> <p>1. Stomatitis, glossitis, cheilitis. The role of resident flora in the occurrence of nonspecific inflammatory lesions of the oral mucosa.</p> <p>2. Immunological bases of etiology and pathogenesis of nonspecific inflammatory lesions.</p> <p>3. Fusospirochetosis (ulcerative necrotic stomatitis of Vincent).</p> <p>4. Bacterial stomatitis (gonococcal, scarlet fever, diphtheria).</p> <p>5. Lesions of the oral mucosa under conditions of tuberculosis, leprosy, syphilis, actinomycosis.</p>	2

	6. Viral stomatitis (influenza, herpes). 7. Lesions of the oral mucosa under conditions of HIV infection, measles, foot and mouth disease. 8. Candidiasis of the oral mucosa. 9. Iatrogenic infection in dental practice (viral hepatitis, AIDS).	
34.	<b>Final test computer control in the discipline *</b>  Test tasks for CTE on the subject	2
35.	<b>Control of practical skills.</b>  List of practical skills for the exam.	2
<b>Together</b>		70

Note: \* - topics from which there must be a positive assessment.

### Independent work

*Table 4*

No	Content	Number hours
1	Preparation for practical classes – theoretical preparation and development of practical skills	35
2	Preparation for the exam	12
3	Elaboration of topics that are not included in the classroom lesson plan:	3
	The main features and trends in the development of modern microbiology. The history of the development of microbiology. Contribution of domestic scientists to the development of microbiology in Ukraine.	1
	Genetics of microorganisms. Genetic research methods: DNA sequence, DNA probe method, PCR, nucleic acid hybridization, etc.	1
	Sanitary and indicator microorganisms	1
Together		50

**Individual tasks** are not provided.

**List of theoretical questions  
for the preparation of higher education applicants for the exam**

1. Definition of microbiology as a science. Branches of microbiology. The subject and tasks of medical microbiology. The main features and trends in the development of modern microbiology.
2. Discovery of microorganisms by A. Levenguk. Stages of development of microbiology. The contribution of L. Pasteur and R. Koch in microbiology. Formation of the main directions of microbiological science. The role of D. Samoilovich, E. Jenner, I. Mechnikov, D. Ivanovsky, P. Ehrlich, S.M. Vinogradsky, E. Bering, G. Ramon, G. Domagko, O. Fleming, D.K. Zabolotny, L.O. Zilber, V.M. Zhdanov, M.P. Chumakov, F. Burnett and other scientists. Development of microbiology in Ukraine.
3. Formation of the main directions of microbiological science. The role of D. Samoilovich, E. Jenner, I. I. Mechnikov, D. Y. Ivanovsky, P. Ehrlich, S. M. Vinogradsky, E. Bering, G. Ramon, H. Domagko, O. Fleming, D. K. Zabolotny, L.O. Zilbera, V.M. Zhdanova, M.P. Chumakova, F. Burnet and other scientists. Development of microbiology in Ukraine.
4. The main differences between prokaryotes and eukaryotes. Forms of bacteria with defects in cell wall synthesis, protoplasts, and spheroplasts. L-forms of bacteria.
5. Morphology and structure of bacteria. The role of separate structures for bacterial activity and in the pathogenesis of infectious diseases. Vegetative forms and spores.
6. Morphology and classification of protozoa.
7. Classification and morphology of fungi.
8. Methods of microscopy. Preparation of bacteriological smears. Dyes and dye solutions; simple and complex methods of dyeing.
9. Principles of organization, equipment and mode of operation of bacteriological, serological and virological laboratories.
10. Bacterioscopic method of research. Stages.
11. Types and mechanisms of bacterial nutrition. Mechanisms of penetration of nutrients into the bacterial cell. Chemical composition of microorganisms. The value of the main components.
12. Respiration of microorganisms. Aerobic and anaerobic types of respiration. Enzymes and cell structures are involved in the process of respiration. Methods of culturing of anaerobic bacteria.
13. Enzymes of microorganisms, their role in metabolism. Use for bacterial differentiation. Pathogenicity enzymes.
14. Growth and methods of bacterial reproduction. Mechanism of cell division, phases of reproduction of bacterial culture in stationary conditions.
15. Bacteriological method of research. Principles of pure bacterial cultures selection and their identification.
16. Influence of physical, chemical and biological factors on microorganisms. Sterilization, methods, control of sterilization efficiency. Asepsis. Antisepsis.
17. Disinfection and sterilization of dental instruments.
18. Extrachromosomal factors of bacterial heredity. Plasmids, their main genetic functions. Migrating elements. The role of mutations, recombination and selection in microbial evolution. The main factors of evolution.
19. Genetic research methods: PCR, DNA probe method, molecular hybridization.
20. Chemotherapy and chemotherapeutic medicaments. Chemotherapeutic index. The mechanism of antibacterial action of sulfonamides. The role of P. Ehrlich and G. Domagk in developing the theory of chemotherapy.
21. The phenomenon of microbial antagonism. The role of Ukrainian microbiologists in developing the doctrine of microbial antagonism. Antibiotics, characteristics, principles of production, units of measurement. Classification by mechanism of action on microorganisms.

22. Drug resistance of microbes, the mechanism of formation of stable forms. Methods for determining the sensitivity of microbes to antibiotics. Minimum inhibitory (MIC) and minimum bactericidal (MBC) concentrations. Practical meaning. Principles of combating drug resistance of microorganisms.
23. Infection. Factors determining the occurrence of an infectious process. The role of microorganisms in the infectious process. Pathogenicity, virulence, units of measurement, methods of determination. Pathogenicity factors of microorganisms, their characteristics.
24. Microbial toxins (exo- and endotoxins). Properties and chemical composition, production, measurement of exotoxin strength. Role in the pathogenesis and immunogenesis of infectious diseases.
25. Phases of development of the infectious process. Mechanisms of infection with pathogenic microorganisms. Bacteremia, toxemia, sepsis. Periods of infectious disease.
26. The role of macroorganisms in the infectious process. Immunological reactivity of the child's body. The influence of the environment and social conditions on the emergence and development of the infectious process in humans. Persistence of bacteria and viruses. The concepts of relapse, reinfection, and superinfection.
27. History of discovery and main stages of development of virology. The contribution of Ukrainian scientists. Methods of studying viruses, their evaluation.
28. Morphology and ultrastructure of viruses. Types of symmetry of viruses. Chemical composition, functions of components of viruses.
29. Bacteriophages, history of the study. Structure, classification of phages by morphology. Methods of qualitative and quantitative determination of bacteriophages. Practical use of bacteriophages.
30. Forms of the interaction of bacteriophages with a bacterial cell. Virulent and moderate phages. Characteristics of productive interaction. Lysogeny and phage conversion.
31. Modern views on the nature and origin of viruses. The place of viruses in the living system.
32. Principles of virus classification. The main properties of human and animal viruses.
33. Virus cultivation methods and their evaluation.
34. Viral hemagglutination and hemadsorption reactions. The mechanisms, practical significance, use, and diagnostic value.
35. Serological reactions used in virology. Virus neutralization reaction, mechanism, principles of use, diagnostic value.
36. Hemagglutination inhibition reaction, its mechanism, conditions of production, principles of use, diagnostic value.
37. Complement fixation test, its essence, evaluation. Features of complement fixation reaction in viral infections.
38. Reactions with labelled antibodies and antigens in virology. Immunofluorescence reaction (RIF), enzyme-linked immunosorbent assay (ELISA).
39. Genetic research methods in virology: PCR, DNA probe method, molecular hybridization
40. Use of cell cultures in virology. Classification of cell cultures. Nutrient media for cell cultivation.
41. Types of interaction between viruses and cells. Characteristics of productive interaction, stages.
42. Features of the pathogenesis of viral infections. Acute and persistent viral infections.
43. Immunological features of viral infections. Factors of antiviral immunity.
44. Methods of virus detection in cell culture and their evaluation. Cytopathogenic action of viruses, its types.
45. Congenital factors protection of the macroorganism from viral agents, their characteristics. Interferons, mechanism of action, interferonogens.
46. Viral vaccines, classification, principles of obtaining, requirements for them, control, evaluation of effectiveness.

47. The doctrine of immunity. Stages of development of immunology. Types of immunity and forms of its manifestation.
48. Factors of innate immunity. Complement, its properties, ways of activation. Phagocytosis, types of phagocytizing cells. Stages of phagocytosis. Completed and incomplete phagocytosis.
49. Factors of innate immunity of oral cavity.
50. The body's immune system, its organs. The role of the thymus gland in the immune response. Cells of the immune system, their varieties, the interaction of T-, B-lymphocytes and macrophages. Their role in cellular and humoral immunity.
51. Patterns of the body's immune response. Phases of the immune response. Immunological reactions. Immunological tolerance, causes of its occurrence. Immunological memory, its mechanism.
52. Patterns of the body's immune response. Phases of the immune response. Immunological reactions. Immunological tolerance, causes of its occurrence. Immunological memory, its mechanism.
53. Immediate and delayed-type hypersensitivity, their mechanisms, differences. Practical meaning.
54. Tricellular system of immune response cooperation. The role of individual cells of the immune system, their interaction. Interleukins.
55. Antigens, their characteristics. Complete and incomplete antigens. Antigenic structure of bacteria. The practical significance of the doctrine of microbial antigens. Autoantigens.
56. Antibodies, their nature. The place of synthesis, dynamics of antibody production. Autoantibodies.
57. Classification of immunoglobulins, their structure and properties. Antigenic structure of immunoglobulins.
58. Antitoxins, their properties, mechanism of action. Principles of antitoxic sera obtaining. Units of measurement, practical use.
59. Immune sera, production principles, control, classification, and use.
60. Serological reactions, their characteristics, main types, and practical use. Agglutination reaction, its mechanism, varieties. Practical use.
61. Serological reactions. Precipitation reaction, its mechanism. Use in medical practice. A gel precipitation reaction.
62. Serological reactions. Lysis reactions. Complement binding reaction, its practical use.
63. Reactions with labelled antibodies or antigens. Practical use of immunofluorescence reaction (RIF), enzyme-linked immunosorbent assay and radioimmunoassay.
64. Forms and types of the immune response. Humoral immune response and its stages.
65. Primary and secondary immune response. Interaction of cells of the immune system in the immune response process.
66. Immune response reactions, their characteristics. Cellular immune response.
67. Immediate and delayed-type hypersensitivity. The mechanism of development of these reactions.
68. Monoclonal antibodies, their production and their use in medical practice.
69. Immunodeficiency states and autoimmune processes. Complex assessment of the immune status of the organism.
70. Live vaccines, principles of production. Control, practical use of live vaccines, evaluation of effectiveness.
71. Vaccines. Obtainment history. Classification of vaccines. Corpuscular, chemical, synthetic, genetically engineered and anti-idiotypic vaccines.
72. Chemical vaccines and toxoids, principles of production. Associated vaccines. Adsorbed vaccines, the principle of "depot".
73. Anatoxins (toxoids), their production, purification, units of measurement, use, and evaluation.
74. Corpuscular vaccines from killed microbes. Principles of obtaining, controlling, and evaluating efficiency.

75. The role of staphylococci in the development of human pathology, the pathogenesis of processes caused by them. Characteristics of toxins and pathogenicity enzymes. The role in the occurrence of nosocomial infection.
76. Methods of microbiological diagnostics of staphylococcal processes and their assessment. Immunity in staphylococcal diseases. Preparations for specific prevention and therapy, assessment.
77. Streptococci, biological properties, classification. Toxins, pathogenicity enzymes.
78. *Streptococcus pneumoniae*, biological properties. Pathogenicity for humans and animals. Microbiological diagnostics of pneumococcal diseases.
79. Streptococci. Role in human pathology. Pathogenesis of streptococcal diseases. Toxins and pathogenicity enzymes of streptococci. Immunity. Methods of microbiological diagnostics of streptococcal diseases.
80. Meningococci, biological properties, classification. Pathogenesis and microbiological diagnostics of meningococcal diseases and bacteremia. Differentiation of meningococci from gram-negative nasopharyngeal diplococci.
81. Gonococci. Biological properties, pathogenesis and microbiological diagnostics of diseases. Prevention and specific therapy of gonorrhea and blenorrhea.
82. Enterobacteria, their evolution. Significance in the development of human pathology. Microbiological diagnostics of colienteritis. *Escherichia*, their properties. Pathogenic *Escherichia* serovars, their differentiation. Microbiological diagnostics of coli-enteritis.
83. *Salmonella* causative agents of typhoid and paratyphoid A and B. Biological properties, antigenic structure. Pathogenesis of diseases. Immunity. Specific prevention and therapy.
84. Pathogenetic bases of microbiological diagnostics of typhoid and paratyphoid A and B. Methods of microbiological diagnostics, their evaluation.
85. *Salmonella* causative agents of acute gastroenteritis, their properties. Principles of classification. Pathogenesis of food toxic infections of salmonellosis nature. Microbiological diagnostics.
86. *Shigella*, biological properties, classification. Pathogenesis of dysentery.
87. *Shigella*. Role in human pathology. Pathogenesis of dysentery, the role of toxins and enzymes in pathogenicity. Immunity. Methods of microbiological diagnostics of dysentery, their assessment.
88. Cholera vibrios, biological properties, biovars. Pathogenesis and immunity in cholera. Methods of microbiological diagnostics of cholera and their evaluation. Specific prevention and therapy of cholera.
89. *Yersinia*. Plague causative agent, history of study, biological properties. The role of domestic scientists in the study of the plague. Pathogenesis, immunity, methods of microbiological diagnostics and specific prevention of plague.
90. The causative agent of tularemia, biological properties. Pathogenesis, immunity, methods of microbiological diagnostics and specific prevention of tularemia.
91. *Brucella*, species, differentiation. Pathogenesis and immunity in brucellosis. Methods of microbiological diagnostics of brucellosis, their assessment. Preparations for specific prevention and therapy.
92. *Klebsiella*, their role in human pathology. Characteristics of *Klebsiella pneumoniae*, ozena, rhinoscleroma. Microbiological diagnostics, specific prevention.
93. *Bordetella*, their properties. The causative agent of whooping cough, morphological, cultural, antigenic properties. Microbiological diagnostics and specific prevention of whooping cough.
94. Anthrax bacilli. Biological features, pathogenesis, microbiological diagnostics and specific prevention of anthrax. The role of domestic scientists in obtaining medicaments for the specific prevention of anthrax.
95. Anaerobic non-clostridial bacteria (bacteroids, peptostreptococci, prevotella, veillonella, etc.), their biological properties. Their importance in the development of general human pathology and pathology of the oral cavity. Peculiarities of microbiological diagnostics of diseases caused by anaerobes.
96. Tetanus Clostridia, properties. Toxin formation. Pathogenesis of tetanus in humans. Microbiological diagnostics, specific prevention and therapy, their theoretical justification and evaluation.

97. Clostridia of botulism. Morphological and cultural features, antigenic structure, toxin production, classification. Pathogenesis, microbiological diagnostics and therapy of botulism.
98. Causative agents of anaerobic wound infection, properties, classification. Pathogenesis and microbiological diagnostics. Methods of specific prevention and therapy of anaerobic wound infection.
99. Corynebacteria, characteristics. Biovars of diphtheria bacilli. Toxin formation, genetic determinants of toxigenicity. Measurement of toxin strength.
100. The causative agent of diphtheria, biological properties. Characteristics of exotoxin. Specific prevention and therapy of diphtheria. Detection of antitoxic immunity. Antidiphtheria medicaments.
101. Pathogenesis of diphtheria, immunity. Microbiological diagnostics of bacteremia. Differentiation of the causative agent of diphtheria and saprophytic corynebacteria.
102. Pathogenic mycobacteria, their role in the development of human pathology. Tuberculosis agents, properties. Types of tuberculosis bacteria. Pathogenesis and microbiological diagnostics of tuberculosis.
103. Microbiological diagnostics of tuberculosis. Immunity in tuberculosis. Specific prevention and therapy of tuberculosis.
104. Tuberculosis mycobacteria, properties. Types of tuberculosis bacteria. Tinctorial and cultural properties. Differentiation of tuberculosis pathogens.
105. The causative agent of leprosy, biological features. Significance in the development of human pathology.
106. Pathogenic fungi and actinomycetes (causing agents of candidiasis, dermatomycosis, actinomycosis, their characteristics). Principles of microbiological diagnostics of mycosis.
107. Pathogenic actinomycetes. Biological properties. Significance in human pathology. Principles of microbiological diagnostics.
108. The causative agent of syphilis. Morphological, cultural properties. Pathogenesis and immunity. Microbiological diagnostics and specific therapy of syphilis.
109. Leptospira, its characteristics, classification. Pathogenesis, immunity and microbiological diagnostics of leptospirosis. Specific prevention and therapy.
110. Borrelia, biological properties. The role in the development of human pathology. The causative agents of epidemic and endemic relapsin fever. Pathogenesis, immunogenesis and microbiological diagnostics of relapsing relapsin fever. Specific prevention and therapy of relapsing typhus.
111. The causative agent of Lyme disease. Pathogenesis of the disease, microbiological diagnostics, therapy and prevention.
112. Rickettsia, biological properties. Classification. Characteristics of human diseases. The causative agent of Q fever. Pathogenesis of the disease, laboratory diagnostics, specific prevention.
113. Rickettsia Causative agents of epidemic and endemic typhus, properties. Pathogenesis of the disease, assessment of methods. Specific prevention, evaluation of medicaments. Laboratory diagnostics.
114. Mycoplasmas, classification. Biological properties, cultivation methods. The role in the development of human pathology. Microbiological diagnostics of mycoplasmosis.
115. Chlamydia, classification, biological properties. Cultivation methods. The role in the development of human pathology. Microbiological diagnostics of chlamydia.
116. Pathogenic spirilla. The causative agent of rat-bite fever. Microbiological diagnostics of the disease.
117. Campylobacter - causative agents of acute intestinal diseases. Biological properties, microbiological diagnostics.
118. Helicobacter pylori the causative agent of human gastroduodenal diseases. Discovery, biological properties, pathogenesis. Methods of microbiological diagnostics. Modern methods of treatment of helicobacter infection.
119. Modern methods of laboratory diagnostics of infectious diseases.
120. Family Orthomyxoviruses. History of discovery, biological properties, classification.
121. Methods of laboratory diagnostics of influenza and their assessment.

122. Antigenic structure and types of antigenic variability of the influenza virus. Modern hypotheses that explain the antigenic variability of orthomyxoviruses.
123. Pathogenesis and immunity in influenza. The role of specific and nonspecific mechanisms in anti-influenza immunity.
124. The problem of specific prevention and therapy of influenza. Medicaments and their evaluation.
125. Family of Paramyxoviruses, general characteristics of the family. Parainfluenza viruses, their biological properties. The role in the development of human pathology. Laboratory diagnostics of parainfluenza infections.
126. Measles virus, biological properties, cultivation. Pathogenesis of infection. Laboratory diagnostics, specific prevention.
127. Epidemic parotitis virus. Pathogenesis of infection. Laboratory diagnostics, specific prevention of mumps.
128. Family of Paramyxoviruses. General characteristics. Respiratory syncytial virus. Biological properties, role in the development of human pathology. Methods of diagnostics of diseases caused by RS viruses.
129. Family of Coronaviruses. General characteristics. Features of SARS and MERS pathogens. Pathogenesis of diseases. Laboratory diagnostics. Prospects of specific prevention.
130. Picornavirus family, general characteristics. Antigenic structure. Biological features of Coxsackie and ECHO viruses. Significance in the development of human pathology.
131. Poliomyelitis viruses, characteristics, classification. Pathogenesis and immunogenesis of infection. Laboratory diagnostics, specific prevention. Eradication of polio worldwide.
132. Genus of Enteroviruses, general characteristics, classification. Laboratory diagnostics of enterovirus infections.
133. Genus Rhinoviruses, biological properties. Classification. Role in human pathology. Methods of laboratory diagnostics of infections caused by rhinoviruses.
134. Rhabdovirus family. Rabies virus, biological properties. Pathogenesis of the disease. Laboratory diagnostics. Specific prevention of rabies.
135. Family of Retroviruses, biological properties. Classification. Mechanism of viral carcinogenesis.
136. Family of Herpesviruses, biological properties, importance in the development of human pathology. Laboratory diagnostics of diseases. Genetic methods of diagnostics.
137. Adenovirus family. Biological properties. Antigenic structure. Cultivation. Pathogenesis and laboratory diagnostics of adenovirus infections. Immunity. Specific prevention.
138. Smallpox virus. Pathogenesis of infection. Methods of diagnostics and specific prevention. Smallpox vaccine virus. Eradication of smallpox worldwide.
139. Viral hepatitis agents, properties and classification of viruses. Pathogenesis of diseases. Laboratory diagnostics. Prospects of specific prevention.
140. Oncogenic viruses, classification. The virus-genetic theory of the occurrence of tumors by L.O. Silber. Mechanisms of viral carcinogenesis.
141. Human immunodeficiency viruses (HIV). Properties. Role in human pathology. Pathogenesis of AIDS. Methods of laboratory diagnostics (immunological, genetic). Prospects of specific prevention and therapy.
142. Prions. Properties. Prion diseases of animals (scrapie, bovine spongiform encephalopathy) and humans (chicken, Creutzfeldt-Jakob disease, etc.). Pathogenesis of prion diseases. Diagnostics.
143. Conditionally pathogenic microorganisms, biological properties, etiological role in the development of opportunistic infections. Characteristics of diseases caused by conditionally pathogenic microorganisms.
144. Normal oral microbiota. Its role in the human body. Changes in microflora depending on age, state of health, loss of teeth, etc.



145. The normal microbiota of the human body, its role in physiological processes and human pathology. Age-related features of the normal microflora of the nose, skin, oral cavity, genitals, and intestine. Gnotobiology. Dysbacteriosis and its causes.
146. Probiotics, prebiotics - preparations for restoring the normal microflora of the human body (bifidobacterin, lactobacterin, colibacterin, bificol, biosporin, bactisubtil, multiprobiotics (Sembiter group, etc.). Mechanism of action.
147. The role of microorganisms in the etiology and pathogenesis of diseases of the teeth (pulpitis, periodontitis), periodontium, mucous membrane of the oral cavity, hard and soft tissues of the maxillofacial apparatus (abscesses, phlegmons, cysts, etc.).
148. Factors of innate immunity of the oral cavity and immunoglobulins.
149. Plaque microbiota, its role in the development of dental caries.
150. Damage to the mucous membrane of the oral cavity in various bacterial and viral infections. Fungal stomatitis.
151. Methods of microbiological diagnostics of infectious pathology of the oral cavity.
152. Sanitary-indicative microorganisms, requirements for them, their significance for the characterization of environmental objects.
153. Water microbiota. Survival of pathogenic microorganisms in water. The role of water in the transmission of infectious diseases. Sanitary and bacteriological control of the quality of drinking water, sanitary and indicator microorganisms.
154. Soil microbiota. sanitary-indicative microorganisms. The role of soil in the transmission of infectious diseases. Factors affecting the survival of pathogenic microorganisms in soil.
155. Air microbiota, its characteristics. sanitary-indicative microorganisms. The role of air in the transmission of infectious diseases.
156. Agents of food poisoning. Principles of sanitary and bacteriological research of food products.
157. The role of water, soil, and air in the transmission of pathogens of viral infections. Viruses that are most often found in environmental objects.
158. The role of the air environment in the spread of pathogens of respiratory viral infections. Methods of indication of respiratory viruses.

### **List of practical skills for the exam**

1. Microscopy the preparation, determine the staining method, morphology and tincture properties of bacteria. (preparations for microscopy: 1) staphylococcus, 2) streptococcus, 3) monobacteria Gr-, 4) capsular bacteria, 5) spores according to Ozheshko, 6) spores according to Peshkov, 7) spores according to Gram, 8) yeast-like fungi, 9) incomplete phagocytosis of diplococci).
2. Prepare a preparation from a culture of bacteria grown on a dense nutrient medium; stain it according to Gram-Blue. Microscopy, determine morphology and tinctorial properties.
3. Prepare a preparation from a culture of bacteria grown on a dense nutrient medium; stain it using a simple method. Microscopy, determine morphology.
4. Prepare a preparation from the patient's sputum, color it according to Tziel-Nielsen, make a microscope, and determine the morphology.
5. The composition and mechanism of action of the Endo media. Practical use.
6. The composition and mechanism of action of Levin's media. Practical use.
7. The composition and mechanism of action of Ploskirev's medium. Practical use.
8. Practical application of the Kitta-Tarozzi medium, its composition and mechanism of action.
9. Observe and evaluate the biochemical properties of the selected pure bacterial culture. Conclude.

10. Observe and evaluate the sensitivity of staphylococcal culture to antibiotics by the method of diagnostic discs. Evaluate, and conclude.
11. Observe and evaluate the minimum inhibitory concentration of cefazolin for staphylococcal culture by the serial dilutions technic. Evaluate, and conclude.
12. Perform the reaction of thermo-ring precipitation by Ascoli to detect antigens of the anthrax pathogen in the studied extract from animal raw materials. Evaluate, conclude
13. Make the agglutination reaction on glass with an unknown culture of bacteria and typhoid diagnostic agglutinating serum. Observe, evaluate, and conclude.
14. Observe and evaluate CFT with the patient's serum and a standard gonococcal antigen. Evaluate and conclude.
15. Describe the cultural properties of bacteria under conditions of their growth on a solid nutrient medium.
16. Determine the titer of saliva lysozyme by the method of serial dilutions.
17. Observe and evaluate the results of the gel precipitation reaction performed to determine the toxigenicity of the studied cultures of *Corynebacterium diphtheria*.
18. Observe and evaluate the results of enzyme-linked immunosorbent assay (ELISA) to detect antibodies to antigens of the syphilis pathogen.
19. Record and evaluate the results of the hemagglutination reaction (HGA) to determine the presence of the parainfluenza virus in the infected chicken embryo. Conclude.
20. Record the results of titration of intestinal bacteriophage in water of an open reservoir according to the Apelman method.
21. Observe and evaluate phagotyping of staphylococcal strains, which are isolated from a) postoperative patient; b) and c) – persons of the medical staff of the surgical department. Identify the phage group. Conclude.
22. Record and evaluate the results of the hemagglutination inhibition reaction (HAI) performed with paired sera of the examinee and standard parotitis diagnostics. Conclude.
23. To evaluate the results of enzyme-linked immunosorbent assay (ELISA) performed with the sera of the examinees in order to detect antibodies to HIV antigens (anti-gr 120). Conclude.
24. To record and evaluate the results of the neutralization reaction (PH) - a colored sample supplied with paired sera of the subject and the diagnosticum - strains of the 1st poliomyelitis virus. Conclude.
25. Record and evaluate the results of the complement binding reaction (CRT) performed with paired sera of the examinee and diagnosticum - a standard specific adenovirus antigen. Conclude.
26. Select the method and mode of disinfection and/or sterilization for specific dental instruments and other medical products.

### **Teaching methods**

- **Verbal** (lecture, explanation, story, conversation, instruction);
- **Visible** (observation, illustration, demonstration);
- **Practical** (execution of graphic works, experiment, practice);
- **Thematic discussions;**
- **Case method;**
- **Simulation tasks;**
- **Research methods;**
- **Presentations, problem presentation of the material.**

## Assessment forms and methods

Entrance control is carried out at the beginning of the study of the academic discipline (at the first contact lesson) in order to determine the readiness of higher education applicants for its assimilation. Control is carried out in the form of testing and is evaluated according to four-point (traditional) scale.

Academic staff carries out current control during practical classes. A teacher evaluates the success of each student in each lesson on a four-point (traditional) scale, taking into account the standardized, generalized criteria for evaluating the knowledge of education applicants of higher education (Table 5). The assessment of success is integrated (all types of work of a student of higher education are evaluated, both in preparation for classes and during classes) according to criteria that are brought to the attention of education applicants of higher education at the beginning of studying the discipline.

### Standardized generalized criteria for evaluating the knowledge of higher education applicants

Table 5

On a 4-point scale	Assessment in ECTS	Evaluation criteria
5 (excellent)	A	The education applicant shows special creative abilities, knows how to acquire knowledge independently, finds and processes the necessary information without the help of a teacher, knows how to use the acquired knowledge and skills to make decisions in non-standard situations, convincingly argues answers, independently reveals his own gifts and inclinations, possesses at least 90 % of knowledge on the topic both during the survey and all types of control.
4 (good)	B	The education applicant is fluent in the studied amount of material, applies it in practice, freely solves exercises and problems in standardized situations, independently corrects errors, the number of which is insignificant, possesses at least 85% knowledge of the topic as during the survey, and all types of control .
	C	The education applicant knows how to compare, summarize, systematize information under the guidance of a scientific and pedagogical worker, in general, independently apply it in practice, control his own activities; correct mistakes, including significant ones, choose arguments to confirm opinions, has at least 75% of knowledge on the topic both during the survey and all types of control.
3 (satisfactory)	D	The education applicant reproduces a significant part of the theoretical material, demonstrates knowledge and understanding of the main basics with the help of a scientific and pedagogical worker, can analyze the educational material, correct errors, among which there are a significant number of significant ones, has at least 65% knowledge of the topic as during the survey, and all types of control.
	E	The education applicant knows educational material at a level higher than the initial one, reproduces a significant part of it at the reproductive level. Has at least 60% knowledge on the topic both during the survey and during

		all types of control.
2 (unsatisfactory)	FX	The education applicant knows the material at the level of individual fragments that is an insignificant part of the material, has less than 60% knowledge of the topic both during the survey and all types of control.
	F	The education applicant possesses the material at the level of basic recognition and reproduction of individual facts, elements, possesses less than 60% of knowledge on the topic during the survey, and all types of control.
On a 4-point scale	Assessment in ECTS	Evaluation criteria
5 (excellent)	AND	The student of education shows special creative abilities, knows how to acquire knowledge independently, finds and processes the necessary information without the help of a teacher, knows how to use the acquired knowledge and skills to make decisions in non-standard situations, convincingly argues answers, independently reveals his own gifts and inclinations, possesses at least 90 % of knowledge on the topic both during the survey and all types of control.
4 (good)	IN	The learner is fluent in the studied amount of material, applies it in practice, freely solves exercises and problems in standardized situations, independently corrects errors, the number of which is insignificant, possesses at least 85% knowledge of the topic as during the survey, and all types of control .
	WITH	The student of education knows how to compare, generalize, systematize information under the guidance of a scientific and pedagogical worker, in general, independently apply it in practice, control his own activities; correct mistakes, including significant ones, choose arguments to support opinions, possess at least 75% of knowledge on the topic both during the survey and all types of control.
3 (satisfactory)	D	The learner reproduces a significant part of the theoretical material, demonstrates knowledge and understanding of the main provisions with the help of a scientific and pedagogical worker, can analyze the educational material, correct errors, among which there are a significant number of significant ones, possesses at least 65% knowledge of the topic as during the survey, and all types of control.
	IS	The learner owns educational material at a level higher than the initial one, reproduces a significant part of it at the reproductive level. has at least 60% knowledge on the topic both during the survey and all types of control.
2 (unsatisfactory)	FX	The learner owns the material at the level of individual fragments that make up an insignificant part of the material, has less than 60% knowledge of the topic both during the survey and all types of control.
	F	The learner possesses the material at the level of basic recognition and reproduction of individual facts, elements, possesses less than 60% of knowledge on the topic during the survey, and all types of control.

The purpose of the exam is to check the level of assimilation of the educational material of the discipline by the education applicants, the ability to use the acquired knowledge, abilities, skills, and other competencies for the successful implementation of professional or further educational activities.

The exam is held in one day in two stages: computer testing and theoretical component. At the first stage, on the day of the exam, in the cathedral's computer classroom, the higher education applicants are tested on 20 questions (time to complete - 20 minutes) from the CTE-1 university database on microbiology, virology and immunology. Each correct answer for a test task when completing a computer control is counted as 1 point (maximum in the amount for the first stage, respectively 20 points). The result of a higher education applicant passing a computer test is not a reason to prevent him from taking the theoretical part of the exam.

The examination card for the discipline contains 2 specific basic theoretical (practically oriented) questions and 1 situational tasks covering the most significant sections of the working curriculum, which are sufficiently covered in literature sources recommended as basic in the study of microbiology, virology and of immunology. Each question of the examination card is evaluated within the range of 0-25 points, the situational task - 0-10 points.

*Table 6*

*Exam structure*

Computer test control 20 tests=20 min.	0-20 points
Oral answer to the question of control of practical and theoretical training according to the module (2 questions)	0-50 points
Oral justification of the answer to the situational problem	0-10 points

Based on the results of the computer control and the theoretical part of the exam, the student is given a total score from 0 to 80 points, the conversion of points into a traditional score is not carried out (Table 7). If the student of higher education violates the rules of academic integrity during the exam, the obtained results are annulled; the student's answer is given an "unsatisfactory" grade (0 points).

***Unified table of correspondence of points for current academic progress, points for FMC, exam, and traditional four-point evaluation***

Average point for current academic progress (A)	Points for current progress from the module (A*24)	Points for FMC of a Module (A*16)	Points for a module and/or exam (A*24 + A*16)	Category of ECTS	By 4-point scale	
2	48	32	80	<b>F FX</b>	2 unsatisfactorily	
2.1	50	34	84			
2.15	52	34	86			
2,2	53	35	88			
2.25	54	36	90			
2,3	55	37	92			
2.35	56	38	94			
2.4	58	38	96			
2.45	59	39	98			
2.5	60	40	100			
2.55	61	41	102			
2.6	62	42	104			
2.65	64	42	106			
2.7	65	43	108			
2.75	66	44	110			
2.8	67	45	112			
2.85	68	46	114			
2.9	70	46	116			
2.95	71	47	118			
3	72	50	122	<b>E</b>	3 satisfactory	
3.05	73	50	123			
3.1	74	50	124			
3.15	76	50	126			
3.2	77	51	128			
3.25	78	52	130	<b>D</b>		4 good
3.3	79	53	132			
3.35	80	54	134			
3,4	82	54	136			
3.45	83	55	138			
3.5	84	56	140	<b>C</b>	4 good	
3.55	85	57	142			
3.6	86	58	144			
3.65	88	58	146			
3.7	89	59	148			
3.75	90	60	150			
3.8	91	61	152			
3.85	92	62	154			

3.9	94	62	156	B	5 excellent
3.95	95	63	158		
4	96	64	160		
4.05	97	65	162		
4.1	98	66	164		
4.15	100	66	166		
4.2	101	67	168		
4.25	102	68	170		
4.3	103	69	172		
4.35	104	70	174		
4.4	106	70	176		
4.45	107	71	178		
4.5	108	72	180	A	
4.55	109	73	182		
4.6	110	74	184		
4.65	112	74	186		
4.7	113	75	188		
4.75	114	76	190		
4.8	115	77	192		
4.85	116	78	194		
4.9	118	78	196		
4.95	119	79	198		
5	120	80	200		

In case of disagreement of the student of higher education with the grade received for the exam, the student of higher education has the right to file an appeal (in accordance with the "Regulations on the appeal of the results of the final control of knowledge of applicants of higher education").

Applicants of higher education who, during the study of microbiology, virology, and immunology, had a current average score of 4.50 to 5.0 are exempted from taking the exam and automatically (with consent) receive a final grade in accordance with Table 7, while the student's presence at the exam is mandatory. In case of disagreement with the assessment, the specified category of higher education applicants will take the exam according to general rules.

The evaluation of the discipline is issued by the department based on the current success rate of the student of higher education (according to table 7).

Incentive points may be added to the total number of discipline points. The maximum number is 20 points. The sum of discipline points and incentive points must not exceed 200 points. Incentive points are awarded to applicants of higher education upon completion of the study of the discipline, after discussion at the departmental meeting, at the request of the head of the department in the name of the dean of the faculty and are subject to mandatory approval by the relevant academic council of the faculty.

Incentive points are awarded for:– active work in the scientific student group of the department;– prize places in the Olympiad in disciplines:– presentations with reports at scientific and scientific

and practical conferences, seminars, congresses and publications of these forums;– authorship or co-authorship in published articles in scientific publications, declaratory patents.

### **System of current and final control**

Current control is carried out during the study of a specific topic to determine the level of formation of a separate skill or ability, the quality of assimilation of a certain portion of educational material through an oral survey, written control of knowledge and skills using written works (written answers to questions, solving situational problems, etc.), test control using a set of standardized tasks (open and closed form tests), programmed control using computer programs for testing, practical testing and self-control.

Applicants for higher education who do not have unworked missed classroom classes, have scored a minimum number of points of at least 72 (corresponding to an average score of 3.0 for the current academic performance), are allowed to take the exam, have fulfilled all the requirements for the academic discipline provided for by the work curriculum (positive grades from substantive modules, admission to the exam in the form of a test control), fulfilled financial obligations according to the concluded agreements (for studies, living in a dormitory, etc.), about which they received a note in the individual study plan for admission to the session from the dean ( deputy dean) of the faculty.

The exam is held in one day in two stages: computer testing and theoretical component. At the first stage, on the day of the exam, in the cathedral's computer classroom, applicants of higher education are tested on 20 questions (time to complete - 20 minutes) from the KTI-1 university database on microbiology, virology and immunology. Each correct answer for a test task when completing a computer control is counted as 1 point (maximum in the amount for the first stage, respectively 20 points). The result of a higher education student passing a computer test is not a reason to prevent him from taking the theoretical part of the exam.

The examination ticket for the discipline contains 2 specific basic theoretical (practically oriented) questions and 1 situational problem covering the most significant sections of the working curriculum, which are sufficiently covered in literary sources recommended as basic (basic) in the study of microbiology, virology and of immunology. Each question of the examination ticket is evaluated within the range of 0-25 points, the situational problem - 0-10 points. Based on the results of the computer control and the theoretical part of the exam, the student is given a total score from 0 to 80 points, the conversion of points into a traditional score is not carried out. If the student of higher education violates the rules of academic integrity during the exam, the obtained results are canceled; the student's answer is given the grade "unsatisfactory" (0 points).

A student of higher education has the right to retake the exam no more than 2 times and only during the exam session.

### **Methodical support**

1. Work program of the academic discipline;
2. List of recommended literature;
3. Multimedia presentations of lectures;
4. Syllabus
5. Materials for monitoring the knowledge, abilities and skills of education seekers (tests of various levels of complexity, tests from the "Krok" licensing exam bank, situational tasks, computer control programs).



## Recommended Books

### Basic (available in the PSMU library)

1. Medical microbiology, virology and immunology - T. V. Andrianova, V. V. Bobyr, V. V. Danyleichenko, etc. / Ed. by V. P. Shyrobokov/ - Vinnytsia: Nova Knyha, 2019. - 744 p.
2. Cappuccino G. Microbiology: A Laboratory Manual, Global Edition, 11th Edition / G.Cappuccino, Chad T. Welsh. - Pearson Higher Ed USA, 2017. - 560 p.
3. Medical Microbiology 27 E (Lange) / K. C. Carroll, S. Morse, T. Mietzner [et al.]. - McGraw-Hill Education, 2016. - 864 p.
4. Murray P.R. Medical Microbiology 8th Edition / P.R. Murray, K.S. Rosenthal, M.A. Pfaller. - Elsevier, 2016. - 848 p.
5. Murray P.R. Basic Medical Microbiology 1st Edition / P.R. Murray. - Elsevier, 2018. - 240 p.
6. Medical Microbiology, International Edition, 19 Ed / M.R. Barer, W. Irving, A. Swann [et al.]. - Elsevier, 2018. - 760 p.
7. Engelkirk P.G. Burton's Microbiology for the Health Sciences / P.G. Engelkirk, J. Duben-Engelkirk, R. Fader. - Wolters Kluwer Health, 2015. - 488 p.
8. Hawley L. Microbiology and Immunology (Board Review Series) Sixth Edition / L. Hawley, R.J. Ziegler, B. L. Clarke. - Lippincott Williams & Wilkins, 2014. - 320 p.
9. General Medical Microbiology, Virology and Immunology. Part I. Manual for practical lessons / Comp. by Loban G.A., Hanch O.V. - Poltava, 2005. -153 p.
10. General Medical Microbiology, Virology and Immunology. Part II. Manual for practical lessons/ Comp. by Loban G.A., Hanch O.V. - Poltava, 2007.- 104 p.
11. Pathogenic cocci. Gramnegative intestinal pathogens. Manual for practical lessons /Composed by Hanch O.V. - Poltava, UMSA, 2006. - 113 p.
12. Oral cavity flora. Manual of Microbiology, Virology and Immunology for dental faculty applicants/ Composed by Hanch O.V.- 2010, Poltava. - 88 p.

### Additional

1. Ananthanarayan R., Paniker C.K. Textbook of Microbiology. - International edition. - 2003. - 612 p.
2. MIMs' Medical Microbiology and Immunology 6th / Richard Goering, Hazel Dockrell, Mark Zuckerman [et al.]. - Elsevier, 2019. - 568 p.
3. Harriott M. Microbiology in Your Pocket: Quick Pathogen Review 1st Edition / M. Harriott. - Thieme, 2018. - 330 p.
4. Medical Microbiology / Patrick R. Murray [et al.]. - 4<sup>th</sup> ed. - An Affiliate of Elsevier Science, 2002. - 826 p.
5. Marsh, P.D. and Martin, M.V. Oral Microbiology, 5th edn. Elsevier: Amsterdam, The Netherlands, 2009. - 300 p.
6. Richard J. Lamont, Robert Burne, Marilyn Lantz, Donald Leblanc. Oral Microbiology and Immunology. Wiley-Blackwell, 2006. - 276 p.

### Information resources

1. Ministry of Education and Science of Ukraine<http://www.mon.gov.ua/>
2. World Health Organization<http://www.who.int/en/>
3. Microbiology and immunology online<http://www.microbiologybook.org/>
4. On-line microbiology notes<http://www.microbiologyinfo.com/>
5. Centers for disease control and prevention[www.cdc.gov](http://www.cdc.gov)
6. Science educational links on Microbiology<https://www.scienceprofonline.com/science-ed-links/science-education-links-microbiology.html>
7. Microbiology Online<https://microbiologyonline.org/index.php>

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