

MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
BELARUSIAN STATE MEDICAL UNIVERSITY

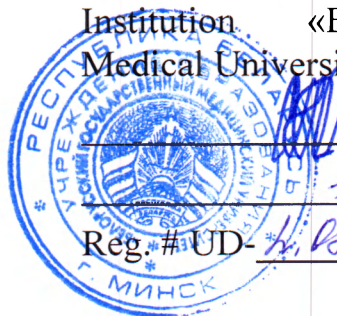
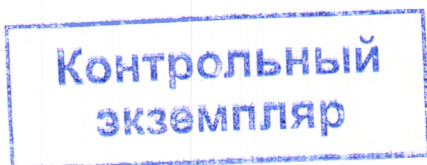
APPROVED

by Rector of the Educational
Institution «Belarusian State
Medical University»

S.P.Rubnikovich

15.11.2023

Reg. # UD- *h. 08-17/2324* /edu.



MICROBIOLOGY, VIROLOGY, IMMUNOLOGY

**Curriculum of the educational institution
in the academic discipline for the specialty**

1-79 01 08 «Pharmacy»

Curriculum is based on the educational program «Microbiology, Virology, Immunology», approved 16.11.2022, registration # УД-L.08-17/2223/уч.; on the educational plan in the specialty 1-79 01 08 «Pharmacy», approved 17.05.2023, registration # 7-07-0912-01/2324/mf.

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RECOMMENDED FOR APPROVAL:

by the Department of Microbiology, Virology, Immunology of the educational institution «Belarusian State Medical University»
(protocol # 4 of 29.09.2023);

by the Scientific and Methodical Council of the educational institution «Belarusian State Medical University»
(protocol # 11 of 15.11.2023)

EXPLANATORY NOTE

«Microbiology, Virology, Immunology» is an academic discipline containing systematized scientific knowledge about pathogenic and non-pathogenic microorganisms for humans, etiology, mechanisms of pathogenesis, specific prevention, etiotropic therapy, methods of laboratory diagnosis of bacterial, viral, fungal infections and protozoal invasions, about the microflora of drugs and methods for assessing their microbial contamination, about the structure and functioning of the human immune system, methods and means of diagnosis, treatment and prevention of diseases based on disorders of the immune system and/or immunological development mechanisms.

The purpose of the academic discipline «Microbiology, Virology, Immunology»:

formation of specialized competence for students to acquire scientific knowledge about the etiology, mechanisms of pathogenesis, laboratory diagnostic methods, the basics of epidemiology, specific prevention and etiotropic therapy of human infectious diseases; about the structure, development, methods of assessing and correcting the functioning of the human immune system, necessary for the professional training and subsequent practical activities of a pharmacist.

The objectives of the academic discipline «Microbiology, Virology, Immunology» are to develop students' scientific knowledge about:

- properties of microorganisms – pathogens of human diseases;
- ways and mechanisms of infection, spread, pathogenesis, clinical manifestations and laboratory diagnostics, prevention and treatment of infectious diseases;
- action of antimicrobial drugs;
- methods for assessing microbial contamination of medicinal raw materials and finished dosage forms, monitoring the sterility and correct storage of medicines;
- basic methods of sterilization, disinfection, asepsis, antiseptics, preservation, necessary in the work of a pharmacist;
- structure and function of the immune system, mechanisms of immunopathology, methods of immunodiagnosis, immunoprophylaxis, immunotherapy.

The knowledge, abilities, skills acquired in the study of the academic discipline «Microbiology, Virology, Immunology» are necessary for the successful study of the following educational modules: «Pharmacology and Pharmacotherapy», «Pharmaceutical Chemistry and Pharmacognosy», «Drug Development and Standardization», «Pharmaceutical Technology».

A student who has mastered the content of the educational material of the academic discipline «Microbiology, Virology, Immunology» should have the following specialized competence:

SC. Possess methods for assessing the microbial contamination of medicines and monitoring the correctness of their storage.

As a result of studying the academic discipline «Microbiology, Virology, Immunology», the student should

know:

place and role of microorganisms in the biosphere, morphology, physiology, genetics, ecology of bacteria, viruses, fungi and protozoa, sensitivity and resistance of

microbes to environmental factors, sources and ways of microbial contamination of plant medicinal raw materials and finished dosage forms, methods of microbiological control of water and air, plant raw materials and finished dosage forms, anti-epidemic and sanitary-hygienic regime in pharmacies;

general patterns of the occurrence and development of bacterial, viral, fungal and protozoal infections and invasions, environmental conditions that promote and prevent the occurrence of infections, opportunistic microbes and opportunistic infections;

the human immune system, mechanisms of innate and acquired immunity, immunopathogenesis of allergic, infectious-allergic and autoimmune diseases, immunodeficiencies, patterns of anti-infectious immunity;

methods for assessing the microbiological quality and sterility of medicines;

be able to:

assess microbial contamination of medicinal plant materials;

record and evaluate the results of determining the sensitivity of bacteria to antibiotics using the standard paper disk method;

record and evaluate the results of serological reactions of agglutination, precipitation, enzyme immunoassay;

prepare microscopic preparations of smears from pure cultures of bacteria and biological fluids and conduct microscopic examination;

differentiate microorganisms by morphological characteristics on micropreparations;

carry out inoculation of the studied material on various media;

disinfect waste infected material;

carry out antiseptic treatment of hands;

master:

skills to ensure drug storage conditions to prevent microbial contamination.

Total number of hours for the study of the discipline is 200 academic hours. Classroom hours according to the types of studies: lectures - 16 hours (including 5 hours of supervised student independent work), laboratory classes - 88 hours; student independent work (self-study) - 99 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (4th semester) and examination (5th semester).

Form of higher education – full-time.

**ALLOCATION OF ACADEMIC TIME
ACCORDING TO SEMESTERS OF STUDY**

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	including			out-of-class self-studies	
				lectures (including supervised independent work)	supervised student independent work	laboratory studies		
1-79 01 08 «Pharmacy»	4	110	64	10	3	54	46	credit
	5	90	40	6	2	34	50	exam

THEMATIC PLAN

Name of section (topic)	Number of class hours	
	lectures	laboratory classes
1. General and sanitary microbiology	6	30
1.1. Microbiology as a science. World of microbes	1	–
1.2. Basic methods for studying the morphology of microorganisms	–	6
1.3. Physiology and biochemical activity of bacteria. Basic principles and methods of bacterial cultivation. Bacteriological research method	1	6
1.4. Genetics of microorganisms		3
1.5. Ecology of microorganisms. Fundamentals of the doctrine of infection. Biological research method	1	3
1.6. Microbiological ground of antimicrobial chemotherapy. Antimicrobial measures	1	6
1.7. Sanitary and bacteriological research methods. Microbiological examination of medicinal raw materials and finished dosage forms	2	6
2. Theoretical and applied medical immunology	4	24
2.1. The immune system. Immunity. Types, immune systems. Immunocompetent cells and molecules	2	3
2.2. Antigens. Antibodies	–	3
2.3. Mechanisms of immune response development	2	3
2.4. Immunodiagnostics. Serological and cellular	–	3

Name of section (topic)	Number of class hours	
	lectures	laboratory classes
reactions		
2.5. Immunopathology. Assessment of immune status. Immunoprophylaxis and immunotherapy of infectious diseases	–	12
3. Medical microbiology	–	20
3.1. Methods for microbiological diagnosis of purulent infections caused by staphylococci, streptococci, and <i>Pseudomonas aeruginosa</i>	–	2
3.2. Methods for microbiological diagnosis of purulent infections caused by <i>Proteus</i> , <i>Bacteroides</i> , <i>Clostridia</i> tetanus, causative agent of gas gangrene	–	2
3.3. Methods for microbiological diagnosis of meningococcal infection, whooping cough, diphtheria	–	2
3.4. Methods for microbiological diagnosis of diseases caused by pathogenic mycobacteria, hemoglobinophilic (hemophilic) bacteria, <i>Klebsiella</i> , <i>Nocardia</i> , <i>Actinomycetes</i>	–	2
3.5. Methods for microbiological diagnosis of acute intestinal infections caused by enterobacteria	–	2
3.6. Methods for microbiological diagnosis of bacterial intestinal infections caused by <i>Vibrio cholerae</i> , <i>Clostridia botulinum</i> , <i>Campylobacter</i> , <i>Helicobacter</i> , <i>Listeria</i>	–	2
3.7. Methods for microbiological diagnosis of sexually transmitted infections	–	2
3.8. Methods for microbiological diagnosis of bacterial zoonotic infections	–	2
3.9. Methods for microbiological diagnosis of rickettsial infections	–	–
3.10. Fundamentals of medical mycology and protozoology	–	4
4. Medical virology	6	14
4.1. General virology. Methods of virological research. Bacteriophages	2	2
4.2. Causative agents of respiratory viral infections: orthomyxoviruses, paramyxoviruses, coronaviruses, adenoviruses. Rubivirus. Parvoviruses	1	2
4.3. Herpesviruses	1	1
4.4. Ecological group of arboviruses and reboviruses		1
4.5. Picornaviruses, reoviruses, noroviruses, hepatitis viruses A, E, B, C	1	2
4.6. Retroviruses, rhabdoviruses, poxviruses, polyoma and papilloma viruses. Oncogenic viruses. Etiology of slow infections. Prions and prion diseases	1	6
Total hours	16	88

CONTENT OF THE EDUCATIONAL MATERIAL

1. GENERAL AND SANITARY MICROBIOLOGY

1.1. Microbiology as a science. World of microbes

Subject, tasks, methods of microbiology. Subject and tasks of microbiology. The main stages of the development of microbiology. Sections of microbiology. Connection of microbiology with other sciences.

The role of microbiology in the progress of medicine, pharmacy and in the professional activities of the pharmacist.

History of microbiology. Early ideas about organisms invisible to the naked eye - contagia. The invention of the microscope and the discovery of the world of microbes by A. Levenhuk. The emergence of scientific microbiology in the second half of the 19th century. (L. Pasteur, R. Koch). Creation of the doctrine of cellular (I.I. Mechnikov) and humoral (P. Ehrlich) mechanisms of immunity of the macroorganism to infectious diseases. The role of D.I. Ivanovsky in the discovery of viruses and the significance of this discovery for biology and medicine. Development of the principles of antiseptics (I. Semmelweis, D. Lister) and chemotherapy (D. L. Romanovsky, P. Ehrlich) of bacterial infections. The main directions of development of microbiology in the 20th and 21st centuries. Development of microbiology in the Republic of Belarus.

Systematics and nomenclature of microorganisms. The place of microorganisms in the organic world. Common and specific characteristics of microorganisms with higher animals and plants.

Principles to the systematics and nomenclature of microorganisms. Phenosystematics. Gene systematics. Use of DNA and 16s rRNA for taxonomy. A mixed approach to taxonomy. Taxonomic categories: domain, phylum (division), class, order, family, genus, species. Subspecies categories: subspecies, variant (var), strain, culture, clone. Species as the main taxonomic category. Species criteria for microorganisms.

Classification of microorganisms. Prokaryotic (bacteria) and eukaryotic (fungi, protozoa) organisms. Viruses, viroids and prions.

International principles and rules for the nomenclature of microorganisms.

Evolution of microorganisms. Origin and development of microorganisms. Factors of evolution. Morphological, biochemical and ecological evolution of microorganisms during the formation of the biosphere. Subsequent evolution of microorganisms. Sources and time of emergence of microorganisms pathogenic for humans. The main directions and driving factors of the evolution of microorganisms in the modern period.

1.2. Basic methods for studying the morphology of microorganisms

Morphology of bacteria. Shapes and sizes of bacteria. Structure of a bacterial cell. Features of the chemical composition of bacteria in comparison with eukaryotic organisms. Structures of a bacterial cell (nucleoid, cytoplasm, ribosomes, mesosomes, inclusions, cell wall, cytoplasmic membrane, periplasmic space, capsule, pili, flagella), their chemical composition and functional significance, identification methods. Differences in the structure of gram-positive and gram-negative bacteria.

Forms of bacteria with a cell wall defect (protoplasts, spheroplasts, L-forms). Bacterial spores, their characteristics.

Methods for studying the morphology of bacteria. Microscopic method: tasks, stages, advantages, disadvantages. Types of microscopic preparations. Technique for preparing fixed and native preparations. Technique of microscopy in a light microscope. Simple and complex methods of staining fixed preparations. Gram staining technique. Methods for studying microorganisms in a living state.

1.3. Physiology and biochemical activity of bacteria. Basic principles and methods of bacterial cultivation. Bacteriological research method

Nutrition of bacteria. Metabolism of bacteria. Sources of carbon, nitrogen and minerals. Growth factors. Autotrophs and heterotrophs. Holophytic mode of nutrition. Mechanisms of nutrient transfer into the bacterial cell.

Respiration of bacteria. Biological oxidation in bacterial metabolism. The main types of biological oxidation of substrates in bacteria. Aerobes, anaerobes, facultative anaerobes, microaerophiles, general characteristics. Methods for cultivating anaerobes.

Growth and reproduction of microorganisms. Phases of reproduction of the bacterial population in liquid and solid nutrient media; colonies of microorganisms; pigments. Biofilms. Types of secretion in bacteria.

Bacterial enzymes. Constitutive and inducible-adaptive enzymes of bacteria. Practical use of the biochemical activity of microorganisms in medical microbiology and in the microbiological industry (for the production of antibiotics, enzymes, vitamins, organic acids, feed protein, etc.), genetic engineering.

Cultural (bacteriological) research method. Principles and methods of bacterial cultivation. Nutrient media for the cultivation of bacteria. Objectives, stages, advantages and disadvantages of the bacteriological research method.

1.4. Genetics of microorganisms

Organization of the genetic apparatus in bacteria. Nucleoid and plasmids. Genotype and phenotype. Organization of the operon.

Modifications in bacteria. Mechanism and phenotypic manifestation.

Mutations and mutagenesis. Spontaneous and induced, gene and chromosomal, direct and reverse mutations in bacteria and their characteristics.

R-S dissociation, mechanism.

Genetic exchange and recombination in bacteria. Transformation, transduction and conjugation. Their mechanisms. Reparations. Principles of genetic mapping.

Extrachromosomal factors of heredity. Definition and general characteristics. Bacterial plasmids. Episomes. Conjugative and non-conjugative plasmids. Types of plasmids (F, R, Col, Ent, Hly, etc.) and their role in determining pathogenic traits and drug resistance in bacteria.

Transposable genome elements – transposons and Is elements.

Genetic control of bacterial virulence.

The importance of mutations, recombinations and reparations in the evolution of microorganisms. Theoretical and practical significance of the study of bacterial genetics for microbiology and medicine.

The concept of genetic engineering.

Genetic analysis methods (molecular hybridization, polymerase chain reaction, nucleic acid sequencing). The importance of genetic methods in the laboratory diagnosis of infectious diseases.

1.5. Ecology of microorganisms. Fundamentals of the doctrine of infection. Biological research method

Ecology of microorganisms. The concept of microbial biocenoses. Symbiotic and antagonistic interactions between a microorganism and other organisms: mutualism, commensalism, synergism, parasitism, antagonism. Microbiological aspects of environmental protection. Microorganisms and the biosphere. Microorganisms as sources of vitamin synthesis.

Microflora of the human body. Microflora of the human body. The role of the microflora of the human body in normal physiological processes and pathology. Obligate (resident) and facultative (transient) microorganisms. Formation of microbial biocenoses in different age periods. Microflora of the skin, oral cavity, gastrointestinal tract, respiratory tract, conjunctiva of the eye, genitourinary tract.

Dysbiosis. Factors influencing the formation of dysbiosis. The treatment and prevention of dysbiosis.

Infection (infectious process) and invasion: definition, general characteristics. Differences between infectious and non-infectious diseases. Causes and conditions for the occurrence of an infectious process. Classification of infectious processes.

Dynamics of development of infectious disease. Periods of infectious disease. Forms of infection: exo- and endogenous, focal and generalized, mono- and mixed; secondary infection, reinfection, superinfection, relapse; acute, chronic, persistent infections, microbial carriage. The concept of wound, respiratory, intestinal, skin, urogenital infections; anthroponotic, zoonotic, diseases transmitted by household contact, airborne droplets, vector-borne and other means.

The role of microorganisms in the infectious process. Pathogenicity. Virulence. Pathogenicity/virulence factors. Types of bacterial exotoxins, targets and mechanisms of action. Pathogenic, opportunistic and non-pathogenic microorganisms.

The role of the macroorganism in the development and course of infectious diseases. The role of lifestyle in the development and course of infectious diseases, the influence of natural and social factors.

Biological (experimental) research method: objectives, stages, advantages, disadvantages, use.

1.6. Microbiological ground of antimicrobial chemotherapy. Antimicrobial measures

Chemotherapy and chemoprophylaxis. Definition of antimicrobial chemotherapy and chemoprophylaxis. The main groups of antimicrobial drugs: sulfonamides, azoles, quinolones, nitrofurans and others, mechanisms of antimicrobial action.

Antibiotics. Definition, requirements for antibiotics. Producers of antibiotics. The main groups of antibiotics: penicillins, cephalosporins, carbapenems, monobactams, aminoglycosides, tetracyclines, chloramphenicol, macrolides, fluoroquinolones, lincosamides, oxazolidinones, polymyxins, cyclopeptides, polyene compounds. Antibiotics of narrow and broad action.

Mechanisms of antimicrobial action of antibiotics. Inhibitors of cell wall synthesis, protein and nucleic acid synthesis. Inhibitors of cytoplasmic membrane synthesis in bacterias and fungi.

Side effects of antibiotics.

Drug resistance of microorganisms and ways to overcome them. The emergence and spread of drug resistance as both a biological and medical problem. Primary and acquired resistance to chemotherapeutic agents. Biochemical and genetic mechanisms of resistance to chemotherapeutic agents. Selective action of antibiotics and other chemotherapeutic drugs as factors in the selection of resistant individuals in the bacteriological population. Pathways to overcome drug resistance.

Methods for determining bacterial resistance to antibiotics.

Influence of physical, chemical, biological factors on microorganisms.

Antimicrobial measures, definition. Microbiological grounds of asepsis, preservation, sterilization, antiseptics and disinfection. The concept of antiseptics and disinfectants. Mechanisms of antimicrobial action of antiseptics and disinfectants.

1.7. Sanitary and bacteriological research methods. Microbiological examination of medicinal raw materials and finished dosage forms

Microflora of air, water, soil. Sanitary indicator microorganisms.

Pharmaceutical microbiology. Sanitary and epidemiological requirements for pharmacies. Sanitary and hygienic regime of pharmacies.

Sanitary and bacteriological study of water and air in pharmacy. Sanitary and bacteriological examination of pharmaceutical glassware, equipment and hands of pharmacy workers.

Phytopathogenic bacteria. Microflora of medicinal raw materials and finished dosage forms

The concept of epiphytic and phytopathogenic microorganisms. Rhizosphere, mycorrhiza, role for plants. Infectious plant diseases caused by phytopathogenic microorganisms, their manifestation. Methods of infection of plants and ways of spreading bacteria in affected plants. Control measures.

Microflora of medicinal raw materials and finished dosage forms. Sources and causes of microbial contamination. Signs of microbial spoilage of dosage forms and measures to prevent it. Endotoxins as a cause of pyrogenicity of injection solutions. Microbiological assessment of herbal medicinal raw materials. Methods for assessing the microbiological purity and sterility of medicines. Microbiological control of water for injection.

2. THEORETICAL AND APPLIED MEDICAL IMMUNOLOGY

2.1. The immune system. Immunity. Types, immune systems. Immunocompetent cells and molecules

Classification of various forms of immunity. Natural and acquired immunity, comparative characteristics.

The immune system. Immunocompetent organs (central and peripheral): structure, functions. Immunocompetent cells: types, morphology, CD markers.

Polymorphonuclear and mononuclear phagocytes: origin, characteristics, functions.

Natural killer cells, mechanism of target damage.

Cytokines: interleukins, interferons, tumor necrosis factors, colony-forming factors.

Innate immunity. Nonspecific factors of protection of the human body. Protective functions of the skin, mucous membranes, connective tissue, normal human microflora.

Humoral nonspecific immunity factors. Proteins of the acute phase of inflammation, lysozyme, lactoferrin and other humoral nonspecific factors.

Phagocytosis. The main stages of phagocytosis and their characteristics. Opsonins and their role in phagocytosis. Immune and non-immune phagocytosis. Completed and incomplete phagocytosis.

Granulocyte system. Activation of neutrophils, bactericidal effect. Antigen presenting cell system. Dendritic cells, their role.

Complement system, activation pathways. Biological functions of proteins of the complement system.

2.2. Antigens. Antibodies

Antigens. General characteristics of antigens. Definition of concepts: antigen, hapten, antigenicity, immunogenicity. Chemical structure of antigens and their determinant groups. Immunochemical specificity of antigens: species, group, type. Autoantigens. Allergens.

Antigenic structure of a bacterial cell: O-, K-, H-antigens. Protective antigens. Antigenic properties of toxins, anatoxins, bacterial enzymes. Antigens of viruses. Antigenic mimicry.

Non-infectious antigens. Human cell antigens: differentiation Ags (CD-AGs), major histocompatibility complex (MHC). Molecules of MHC classes I and II: structure, distribution on cells, biological significance.

Antibodies. Antibodies (immunoglobulins). Classes of immunoglobulins, their main characteristics. Functions of antibodies. Dynamics of antibody formation.

The concept of monoclonal antibodies, methods of production, significance.

2.3. Mechanisms of immune response development

Antigen-presenting cells (APC): types, characteristics. Interaction of APC with antigens.

B lymphocytes: development and differentiation. B cell subpopulations. The role of B lymphocytes.

Humoral immune response: definition, dynamics of development, manifestations. Primary and secondary immune response, switching the biosynthesis of immunoglobulin classes, immunological memory.

T-lymphocytes: Subpopulations of T-cells (T-helper null, T-helper types 1 and 2, follicular T-helper, T-regulatory, cytotoxic T-lymphocytes, memory T-lymphocytes). Spectrum of produced cytokines. T cell receptor. The role of different subpopulations in the immune response.

Cellular immune response: dynamics of development, manifestations.

T-dependent effector and regulatory mechanisms.

Immunological tolerance, central and peripheral. Conditions for the development and manifestation of immunological tolerance.

2.4. Immunodiagnosics. Serological and cellular reactions

Antigen-antibody reactions (serological reactions). General characteristics of reactions: specificity and sensitivity, reversibility, optimal ratios of ingredients. Reaction mechanism, diagnostic value.

Serological research method: tasks, stages, assessment. Diagnosticums, diagnostic immune sera, titer of immune sera, diagnostic titer, increase in antibody titer.

Types of serological reactions. Agglutination reactions (RA), indirect/passive hemagglutination (IRHA/RPHA), latex agglutination, immunoprecipitation. Immune lysis reactions. Complement fixation reaction.

Solid-phase immunological analysis: immunofluorescence reaction (RIF), immunoelectron microscopy (IEM), enzyme-linked immunosorbent assay (ELISA), immunochromatographic analysis (ICA) - essence, formulation options, accounting, evaluation, application. Immunoblotting (Western blotting). Express tests.

2.5. Immunopathology. Assessment of immune status. Immunoprophylaxis and immunotherapy of infectious diseases

Allergy. Stages and mechanisms of allergy development.

Immediate hypersensitivity. Types of GNT: anaphylactic, cytotoxic, immunocomplex, antireceptor. Immunopathological mechanisms. Autoimmune diseases occurring through the mechanisms of HNT.

Delayed-type hypersensitivity (DTH). The role of HRT in immunity. Skin allergy tests and their diagnostic value.

Prevention of allergic diseases in pharmaceutical production and at home.

Immune status of the human body. Definition, indicators, methods for determining and assessing immune status.

Types of immunopathology. Classification of immunopathological reactions.

Congenital and acquired immunodeficiency conditions. Primary and secondary immunodeficiencies.

Autoimmune diseases: classification, mechanisms of damage to organs, cells and tissues. Autoantigens. Autoantibodies, meaning of definition in clinical practice.

Transplant immunity. Antitumor immunity, immunity in the mother-fetus system.

Immunomodulators (interferons, interleukins). Natural and synthetic immunomodulators. Immunosuppressants.

Immunoprophylaxis and immunotherapy of infectious diseases. Principles of immunoprophylaxis and immunotherapy, indications for implementation. Characteristics of modern vaccine preparations: live, inactivated and chemical vaccines, toxoids, associated vaccines, genetically engineered and synthetic vaccines.

Serotherapy and seroprophylaxis. Characteristics of antitoxic, antibacterial and antiviral immune sera and immunoglobulins, their preparation. Immunoglobulin for intravenous administration.

3. MEDICAL MICROBIOLOGY

3.1. Methods for microbiological diagnosis of purulent infections caused by staphylococci, streptococci, and *Pseudomonas aeruginosa*

Staphylococci: Properties. Pathogenicity factors. Etiological and pathogenetic role of staphylococci in purulent-inflammatory processes, sepsis, nosocomial infections. Laboratory diagnostics, specific prevention and etiotropic therapy of staphylococcal infections.

Streptococci: Properties. Pathogenicity factors and toxins. Role in human pathology. Laboratory diagnosis, prevention and etiotropic therapy of streptococcal infections.

The concept of enterococci and enterococcal infections.

Pseudomonas: Properties. Ecology. Pathogenicity factors. The role of *Pseudomonas aeruginosa* in nosocomial infections. Laboratory diagnostics. Prevention, etiotropic therapy.

3.2. Methods for microbiological diagnosis of purulent infections caused by *Proteus*, *Bacteroides*, *Clostridia tetanus*, causative agent of gas gangrene

Proteus: classification, properties. The role of *Proteus* in human pathology.

Clostridia are causative agents of wound anaerobic infection. Toxins and their characteristics. The role of clostridia toxins and tissue breakdown products in the pathogenesis of wound infection. Microbial associations in wound anaerobic infection. Antitoxic immunity. Laboratory diagnosis, specific prevention and etiotropic therapy of wound anaerobic infection.

Clostridia are the causative agents of tetanus. Tetanospasmin and tetanolysin, their pathogenetic effect. Tetanus in newborns. Antitoxic immunity. Laboratory diagnosis, specific prevention and etiotropic therapy of tetanus.

Bacteroides, characteristics, role in human pathology. Principles of diagnosis of non-clostridial anaerobic infections.

3.3. Methods for microbiological diagnosis of meningococcal infection, whooping cough, diphtheria

Meningococci. Properties. Pathogenicity factors. Etiological and pathogenetic role in epidemic cerebrospinal meningitis, meningococemia and nasopharyngitis. Bacterial carriage. Immunity for meningococcal infection. Laboratory diagnostics. Prevention, etiotropic therapy.

The causative agent of diphtheria. Properties. Pathogenicity factors. Diphtheria toxin, its properties. Mechanism of action. Genetic control of toxin production. Anatoxin. Antitoxic immunity and methods for its detection. Bacterial carriage. Laboratory diagnosis, specific prevention and etiotropic therapy of diphtheria.

The causative agent of whooping cough. Properties. Pathogenicity factors. Pathogenesis and immunity. Laboratory diagnostics, specific prevention, etiotropic therapy of whooping cough.

3.4. Methods for microbiological diagnosis of diseases caused by pathogenic mycobacteria, hemoglobinophilic (hemophilic) bacteria, *Klebsiella*, *Nocardia*, *Actinomycetes*

The causative agent of tuberculosis. Properties. Pathogenicity for humans and localization in the body. Pathogenicity factors of *Mycobacterium tuberculosis*. Tuberculin. Immunity and its features. Allergy. Laboratory diagnosis of tuberculosis, specific prevention (BCG vaccine), etiotropic therapy.

The causative agent of leprosy. Biological features. Pathogenicity for humans. Laboratory diagnosis of leprosy. Prevention of leprosy, etiotropic therapy.

Nocardia. Systematic position, properties, role in human pathology.

Actinomycetes. Systematic position, general characteristics, distribution. The role of actinomycetes in the cycle of substances, the production of antibiotics. Etiology, pathogenesis, microbiological diagnosis of actinomycosis.

Hemoglobinophilic (hemophilic) bacteria. *Haemophilus influenzae* and its role in the pathology of children and adults. Microbiological diagnosis and specific prevention of Hib infection.

***Klebsiella*,** general characteristics. Opportunistic *Klebsiella* (*K. pneumoniae*, *K. oxytoca*) and their role in human pathology. *K. pneumoniae* and their role in infectious pathology. Microbiological diagnosis of klebsiellosis.

Legionella. Systematic position, properties, role in human pathology.

3.5. Methods for microbiological diagnosis of acute intestinal infections caused by enterobacteria

Escherichia. Properties, physiological role and sanitary-indicative value. *Escherichia* serogroups and their role in the etiology of acute intestinal diseases (escherichiosis): enteritis of early childhood, dysentery-like diseases, cholera-like diseases. Enterohemorrhagic *Escherichia* is the causative agent of hemolytic-uremic syndrome. The etiological and pathogenetic role of *Escherichia* in urinary tract infections, appendicitis, cholecystitis and nosocomial infections. Immunity. Laboratory diagnosis of escherichiosis. Prevention, etiotropic therapy.

Shigella. Classification of *Shigella*. Etiological role in dysentery. Pathogenesis of the disease. Intracellular persistence of the pathogen. Laboratory diagnosis of dysentery. Prevention and etiotropic therapy.

Salmonella. Serological classification of *Salmonella* Kaufman-White. Pathogenicity for humans. Causative agents of typhoid fever and paratyphoid fever. Pathogenesis and immunology of typhoid fever. *Salmonella* is the causative agent of acute gastroenteritis. Pathogenesis of diseases. *Salmonella* are causative agents of nosocomial infections. Laboratory diagnosis of typhoid fever and salmonellosis. Prevention and etiotropic therapy.

Yersinia is the causative agent of pseudotuberculosis and enterocolitis. Morphological and physiological features. Pathogenicity for humans and rodents. Laboratory diagnosis of yersiniosis. Prevention, etiotropic therapy.

3.6. Methods for microbiological diagnosis of bacterial intestinal infections caused by *Vibrio cholerae*, *Clostridia botulinum*, *Campylobacter*, *Helicobacter*, *Listeria*

***Vibrio cholerae*.** Morphological, cultural and biochemical characteristics. Antigenic structure, O- and H-antigens. *Vibrio cholerae* biovars. Serovars. Ecology. Resistance. Pathogenicity factors. Genetic control of pathogenicity factors. Enterotoxin (cholerogen), properties and mechanism of pathogenetic action. Pathogenesis and immunity in cholera. Laboratory diagnostics, specific prevention, etiotropic therapy of cholera.

Clostridia are the causative agents of botulism. Botulinum toxins. Characteristics and pathogenetic effect. Laboratory diagnostics, specific treatment, prevention of botulism.

Clostridium difficile: natural (species) antibiotic resistance. Clostridioides difficile-associated infections, methods of diagnosis and therapy.

Campylobacter: systematic position, properties, role in human pathology.

Helicobacter. Properties, role in the development of gastric and duodenal ulcers, stomach cancer, maltoma. Laboratory diagnosis, prevention and etiotropic therapy.

Listeria: systematic position, properties, role in human pathology.

3.7. Methods for microbiological diagnosis of sexually transmitted infections

The causative agent of syphilis. Properties. Pathogenesis and immunity. Laboratory diagnostics. Prevention, etiotropic therapy.

Gonococci. Etiological and pathogenetic role in urethritis and conjunctivitis in children. Prevention of blenorrhea in newborns. Immunity. Laboratory diagnosis of gonorrhea. Prevention, etiotropic therapy.

Chlamydia. Morphological and biological features. Resistance. Obligate intracellular parasitism. Chlamydia pathogenicity factors. The causative agent of urogenital chlamydia. Role in pregnancy pathology and fetal damage. Material and diagnostic methods. Laboratory diagnosis of chlamydia, prevention, etiotropic therapy.

Mycoplasmas, general characteristics, pathogenicity for humans, diseases caused, role in the pathology of pregnancy and damage to the fetus. Laboratory diagnosis of mycoplasmosis, prevention, etiotropic therapy.

3.8. Methods for microbiological diagnosis of bacterial zoonotic infections

Classification of microorganisms and poisons of biological origin according to the degree of danger. Anti-epidemic regime when working with pathogens of risk groups IV-III.

The causative agent of plague. Morphological and physiological features. Pathogenicity for humans. Pathogenicity factors and toxins. Pathogenesis of plague. Immunity. Laboratory diagnostics, specific prevention, etiotropic therapy of plague.

The causative agent of tularemia. Morphological, cultural and biochemical characteristics. Ecology. Resistance. Pathogenicity for humans. Pathogenicity factors. Pathogenesis and immunity in tularemia. Diagnostic methods. Live tularemia vaccine (B.Ya. Elbert, N.A. Gaisky). Medicines for chemotherapy of tularemia.

Brucella. Morphological, cultural, biochemical and antigenic properties. Ecology. Resistance. Pathogenicity factors. Pathogenesis and immunity in brucellosis. Laboratory diagnostics, specific prevention, etiologic therapy.

Bacilli. The causative agent of anthrax. Morphological, cultural and biochemical properties. Ecology. Spore resistance to environmental factors. Pathogenicity factors. Toxins, their pathogenic effects. Laboratory diagnosis, prevention and etiologic therapy of anthrax.

Aerobic bacilli are the causative agents of food poisoning.

Leptospira: general characteristics, pathogenicity for humans. Pathogenesis of leptospirosis. Immunity. Laboratory diagnostics. Specific prevention, etiologic therapy.

Borrelia: general characteristics, pathogenicity for humans. Characteristics of pathogens, transmission routes, basis of pathogenesis, laboratory diagnostic methods and etiologic therapy of Lyme borreliosis.

3.9. Methods for microbiological diagnosis of rickettsial infections

Rickettsia. Classification of rickettsia and rickettsioses. Causative agents of typhus and Brill-Zinsser disease, endemic rickettsioses. Ecology. Resistance. Hosts and carriers. Obligate intracellular parasitism of Rickettsia. Laboratory diagnosis of rickettsioses. Specific prevention, etiologic therapy.

3.10. Fundamentals of medical mycology and protozoology

Systematic and classification of fungi.

Fungi pathogenic to humans, morphology, pathogenicity factors. Features of mycotic infection. Principles of diagnosis and features of chemotherapy for mycoses.

Systematic, general characteristics and classification of protozoa. Features of chemoprophylaxis and chemotherapy of protozoal invasions.

4. MEDICAL VIROLOGY

4.1. General virology. Methods of virological research. Bacteriophages

Classification and morphology of viruses. Viruses as an independent form of life. The main features that distinguish viruses from other forms of organic matter. Classification of viruses. Morphology of virions of simple (non-enveloped) and complex (enveloped) viruses. Chemical composition of viruses. Viroids. Prions.

Reproduction of viruses. Strict parasitism and cytotropism of viruses. Stages of reproduction (reproduction) of viruses. Features of the reproduction of DNA and RNA viruses. Mechanisms of virus variability. Productive, abortive and integrative cell infection.

Ecology of viruses. Human and animal viruses. Sensitivity of viruses to physical and chemical environmental factors.

Bacterial viruses (bacteriophages). Morphology of phage particles, chemical composition, properties. Virulent and temperate phages and features of their interaction with bacteria. Lysogenic infection. Phage conversion. Defective phages. Use of phages for diagnosis, treatment and prevention of bacterial infections. Phage typing of bacteria. Sanitary and indicative significance of bacteriophages.

Viral infections. Viruses as a cause of the development of tumor and infectious diseases. Distribution, features of viral infections. Types of viral infections. Mechanisms of viruses infecting animal cells. Slow infections.

Antiviral immunity. Factors of innate immunity. Cellular unresponsiveness. Antiviral inhibitors. Natural killers. Viral interference. Interferonogens. Interferons, types, classes, properties, antiviral, antitumor, immunomodulatory effects.

Features of immunity in viral infections. Immunoprophylaxis and immunotherapy of viral infections.

Chemotherapy and chemoprophylaxis of viral infections. Antiviral chemotherapeutic drugs and their mechanisms of action. Antiviral antiseptics.

Study of the morphology of viruses. Detection of viral inclusions. Methods for isolating, indicating and identifying viruses in chicken embryos, cell cultures, and laboratory animals. Serological methods for diagnosing viral infections.

4.2. Causative agents of respiratory viral infections: orthomyxoviruses, paramyxoviruses, coronaviruses, adenoviruses. Rubivirus. Parvoviruses

Human influenza viruses. Structure and chemical composition of virions. Influenza virus antigens: hemagglutinin, neuraminidase, ribonucleoprotein proteins. Antigenic variability of the influenza virus, antigenic drift, shift. Ecology. Cultivation. Pathogenesis of influenza. The role of secondary bacterial microflora. Immunity. Laboratory diagnostics, specific prevention, etiotropic therapy.

Paramyxoviruses. General characteristics of properties. Genus of paramyxoviruses: parainfluenza viruses. Role in human pathology. Immunity. Mumps virus. Cultivation. Pathogenetic features of the disease. Immunity. Specific prevention.

The genus of pneumoviruses is respiratory syncytial virus (RSV). Cultivation. Pathogenetic features of diseases. Immunity.

Morbilivirus genus: measles virus. Pathogenetic features of the disease. Immunity. Specific prevention.

Laboratory diagnosis of paramyxovirus infections.

Coronaviruses. General characteristics, properties. SARS-Cov-2 virus. Covid-19 infection – pathogenesis, diagnosis, specific prevention, antiviral therapy.

Adenoviruses: characteristics, family composition. Human adenoviruses, virion structure, virus properties, serotypes. Pathogenesis, immunity, virological diagnosis, specific prevention of adenoviral infections.

Rubiviruses. Rubella virus, structure, properties, teratogenic effect. Rubella, pathogenesis, virological diagnosis, principles of prevention.

Parvoviruses, virion structure, biological properties, role in human pathology.

4.3. Herpesviruses

Herpesviruses: characteristics and family composition, oncogenicity. Human herpes viruses (HHV):

alpha-Herpesviruses. Herpes simplex viruses are serotypes HSV-1 and HSV-2. Pathogenetic features of the disease. Persistence. Immunity.

Varicella zoster virus. Formation of intranuclear inclusions in epithelial skin cells. Pathogenetic features of the disease.

beta-Herpesviruses. Cytomegalovirus (HHV-5), properties. Forms of cytomegalovirus infection. HHV-6, 7, role in human pathology (roseola infantum, chronic fatigue syndrome);

Gamma Herpesviruses. Epstein-Barr virus (HHV-4), properties. Pathogenesis, diagnosis of infectious mononucleosis. HHV-8, role in human pathology (Kaposi's sarcoma).

4.4. Ecological group of arboviruses and reoviruses

General characteristics of arboviruses, composition of the group, characteristics of the diseases caused. Arboviral and reoviral infections endemic to the Republic of Belarus.

Flaviviruses: Characteristics and classification. Tick-borne encephalitis virus. Specific prevention. Other diseases caused by flaviviruses (Dengue fever, yellow fever, Japanese encephalitis, Zika fever).

4.5. Picornaviruses, reoviruses, noroviruses, hepatitis viruses A, E, B, C

Picornaviruses. General characteristics, properties.

Enteroviruses: polio, Coxsackie and ECHO viruses. Features of properties. Localization and spread of the polio virus in the human body. Immunity. Specific prevention. Diseases caused by Coxsackie and ECHO viruses in humans. Rhinoviruses.

Laboratory diagnosis of diseases caused by picornaviruses.

Reoviruses: general characteristics of the family. Rotaviruses, virion structure. Human rotavirus infection: pathogenesis, immunity, diagnostic methods.

Noroviruses: virion structure, biological properties, role in human pathology.

Classification of hepatitis viruses (HAV, HBV, HCV, HEV), other viruses with hepatotropic effects.

Hepatitis A virus, structure and properties of the virion. Methods of infection, pathogenesis, immunity, diagnosis, specific and nonspecific prevention of hepatitis A.

Hepatitis E virus, characteristics of the virion. Pathogenesis and virological diagnosis of hepatitis E.

Hepatitis B virus. Morphological and antigenic structure of the virion, oncogenicity. Routes of transmission, pathogenesis, immunity, virological diagnosis, principles of treatment. Specific and nonspecific prevention of hepatitis B. Delta infection, pathogenesis, diagnosis.

Hepatitis C virus, virion structure. Pathogenesis, immunity, virological diagnosis, outcomes of hepatitis C. Medicines for specific therapy of hepatitis C.

4.6. Retroviruses, rhabdoviruses, poxviruses, polyoma and papilloma viruses. Oncogenic viruses. Etiology of slow infections. Prions and prion diseases

Retroviruses: Human immunodeficiency viruses (HIV-1 and HIV-2). Virion structure. Stages of virus reproduction in T-lymphocytes. Sensitivity to physical and chemical factors. HIV infection. Spreading. Methods of infection. Groups at increased risk of infection. Formation of immunodeficiency and its characteristics. Diagnosis of HIV infection. Principles of antiretroviral therapy (ART). Primary and secondary prevention of HIV infection.

Rhabdoviruses. Rabies virus: properties. Routes of human infection, pathogenesis and virological diagnosis of rabies. Babes-Negri inclusions. Modern rabies vaccine and gamma globulin for the prevention of rabies, indications for use.

Poxviruses: characteristics and composition of the family.

Polyoma and papillomaviruses. Human papillomaviruses of high carcinogenic risk. The role of papillomaviruses in the etiology of cervical cancer, principles of prevention.

History of the development of ideas about the etiology of malignant tumors. Viral hypothesis of carcinogenesis. The concept of «oncogenicity of the virus».

Oncogenic DNA genomic viruses and RNA genomic viruses – a mechanism of carcinogenesis.

Prions: properties, role in human pathology. Prevention.

Slow infections of viral etiology (HIV infection, subacute sclerosing panencephalitis, rabies, congenital rubella, chronic viral hepatitis B and C, herpetic encephalitis).

**ACADEMIC DISCIPLINE CURRICULAR CHART OF THE EDUCATIONAL DISCIPLINE
«MICROBIOLOGY, VIRUSOLOGY, IMMUNOLOGY»**

Section number, topic	Title of section, topic	Number of classrooms				Self-studies	Forms of knowledge control
		lectures	GIW	laboratory classes			
	4 semester	10	3	54	46		
1	General and sanitary microbiology	6	2	30	25		
1.1	Microbiology as a science. The world of microorganisms.						
1.2	Systematics, nomenclature and classification of microorganisms. Physiology of microorganisms	2	1	-	-		Interview
1.2	Morphology of microorganisms. Basic forms of bacteria. Bacterioscopic research method. Simple staining methods	-	-	3	2		Interview, quiz, written lab report, tests
1.2	Bacterioscopic research method. Structure of a bacterial cell. Complex staining methods. Features of morphology and methods for studying spirochetes, rickettsia, chlamydia, mycoplasmas	-	-	3	2		Interview, quiz, written lab report, tests
1.3	Physiology of microorganisms						
	Cultural (bacteriological) research method. Methods for isolating pure bacterial cultures	-	-	3	2		Interview, quiz, written lab report, tests
1.3	Cultural (bacteriological) research method. Methods for identifying pure bacterial cultures	-	-	3	2		Interview, quiz, written lab report, tests
1.4	Genetics of microorganisms.						
	Methods for studying the genetics of bacteria. Genetics methods	-	-	3	2		Interview, quiz, written lab report, tests
1.5	Ecology of microorganisms. Fundamentals of the doctrine of infection. Microbiological basis of antimicrobial chemotherapy.	2	0,5	-			Interview
1.6							

1.5	Ecology of microorganisms. Methods for studying the normal microflora of the human body. Fundamentals of the doctrine of infection	-	-	3	2	Interview, quiz, written lab report, tests
1.6	Microbiological basis of antimicrobial chemotherapy. Methods for studying the sensitivity of microorganisms to antibiotics	-	-	3	3	Interview, quiz, written lab report, tests
1.6	Antimicrobial measures: methods of sterilization and disinfection. Asepsis	-	-	3	3	Interview, quiz, written lab report, tests
1.7	Sanitary and bacteriological research methods. Microbiological examination of medicinal raw materials and finished dosage forms	2	0,5	3	2	Interview, quiz, written lab report, tests
	Final test: «General Microbiology»	-	-	3	5	Interview, tests
2	Theoretical and applied medical immunology	4	1	24	21	
2.1	Immunology. The immune system. Innate immunity	2	0,5	3	2	Interview, quiz, written lab report, tests
2.2	Antigens. Antibodies	-	-	3	2	Interview, quiz, written lab report, tests
2.3	Humoral and cellular immune response.	2	0,5	3	3	Interview, quiz, written lab report, tests
2.4	Immunodiagnosics. Serological and cellular reactions	-	-	3	2	Interview, quiz, written lab report, tests
2.5	Methods of clinical and infectious immunology. Allergy	-	-	3	3	Interview, quiz, written lab report, tests
2.5	Anti-infective immunity. Immunoprophylaxis and immunotherapy of infectious diseases.	-	-	3	2	Interview, quiz, written lab report, tests
2.5	Immune status. Immunodeficiency. Autoimmune diseases. The concept of immunocorrection	-	-	3	3	Interview, quiz, written lab report, tests
	Final test: «Theoretical and applied medical immunology»	-	-	3	4	Interview, tests. Credit
	5 semester	6	2	34	50	
3	Medical microbiology	-	-	20	33	
3.1	Methods for microbiological diagnosis of wound infections and purulent-inflammatory processes caused by <i>Staphylococci</i> , <i>Streptococci</i> , <i>Pseudomonas aeruginosa</i>	-	-	2	3	Interview, quiz, written lab report, tests

3.2	Methods for microbiological diagnosis of wound infections and purulent-inflammatory processes caused by <i>Proteus</i> , <i>Bacteroides</i> , <i>Clostridias</i>	-	-	2	3	Interview, quiz, written lab report, tests
3.3	Methods for microbiological diagnosis of meningococcal infection, whooping cough, diphtheria.	-	-	2	3	Interview, quiz, written lab report, tests
3.4	Methods for microbiological diagnosis of diseases caused by pathogenic mycobacteria, hemoglobinophilic (hemophilic) bacteria, <i>Klebsiella</i> , <i>Nocardia</i> , <i>Actinomyces</i>	-	-	2	3	Interview, quiz, written lab report, tests
3.5	Methods for microbiological diagnosis of acute intestinal infections caused by enterobacteria.	-	-	2	3	Interview, quiz, written lab report, tests
3.6	Methods for microbiological diagnosis of bacterial intestinal infections caused by <i>Vibrio cholerae</i> , <i>Clostridia botulinum</i> , <i>Campylobacter</i> , <i>Helicobacter</i> , <i>Listeria</i>	-	-	2	3	Interview, quiz, written lab report, tests
3.7	Methods for microbiological diagnosis of sexually transmitted infections	-	-	2	3	Interview, quiz, written lab report, tests
3.8	Methods for microbiological diagnosis of bacterial zoonotic infections	-	-	2	3	Interview, quiz, written lab report, tests
3.9	Fundamentals of medical mycology and protozoology	-	-	2	3	Interview, quiz, written lab report, tests
	Final test: «Medical microbiology»	-	-	2	6	Interview, tests
4	General and medical virology	6	2	14	17	
4.1	General virology. Viral infections. Antiviral immunity. Chemotherapy and chemoprophylaxis of viral infections	2	05	-	-	Interview
4.1	General virology. Virological research methods	-	-	2	2	Interview, quiz, written lab report, tests
4.2	Orthomyxoviruses. Paromyxoviruses. Coronaviruses.					
4.3	Adenoviruses. Rubivirus. Parvoviruses. Herpes viruses.	2	0,5	-	-	Interview
4.4	Ecological group of arboviruses and roboviruses					
4.2	Methods for virological diagnosis of respiratory infections caused by orthomyxoviruses, paramyxoviruses, coronaviruses, adenoviruses, rubiviruses, parvoviruses.	-	-	2	2	Interview, quiz, written lab report, tests
4.3	Methods for virological diagnosis of diseases caused by herpesviruses, arboviruses and roboviruses.	-	-	2	2	Interview, quiz, written lab report, tests

4.5	Picornaviruses, reoviruses, noroviruses, hepatitis viruses A, E, B, C.							
4.6	Retroviruses, rhabdoviruses, poxviruses, polyoma and papilloma viruses. Oncogenic viruses. Etiology of slow infections. Prions and prion diseases	2	1	-	-			Interview
4.5	Methods for virological diagnosis of diseases caused by picornaviruses, reoviruses, noraviruses	-	-	2	2			Interview, quiz, written lab report, tests
4.6	Methods for virological diagnosis of diseases caused by retroviruses, rhabdoviruses, Etiology of slow infections. Prions and prion diseases	-	-	2	2			Interview, quiz, written lab report, tests
4.6	Methods for virological diagnosis of diseases caused by poxviruses, polyoma and papilloma viruses. Oncogenic viruses	-	-	2	2			Interview, quiz, written lab report, tests
	Final lesson «Medical microbiology», «General and private medical virology»	-	-	2	2			Interview, tests. Exam
	Total hours	16	5	88	96			

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic (relevant):

1. Generalov, I. I. Medical Microbiology, Virology & Immunology : lecture course for students of medical universities. Pt. 1 : General Microbiology & Medical Immunology / I. I. Generalov.- Vitebsk : VSMU, 2016. - 281 p.

2. Generalov, I. I. Medical Microbiology, Virology & Immunology : lecture course for students of medical universities. Pt. 2 : Medical Bacteriology & Medical Virology / I. I. Generalov. - Vitebsk : VSMU, 2016. - 390 p.

3. Apurba Sankar Sastry, Sandhya Bhat K, Essentials of Medical Microbiology© Jaypee Brothers Medical Publishers, 2016 - 656 p.

Additional:

4. Manual of Clinical Microbiology. – 11th ed.; editor in chief, James H. Jorgensen, American Society for Microbiology, 2015. - p. 2892.

5. Tortora, Gerard J., Education Microbiology in introduction \ Tortora, Gerard J.Funke, Berdell R., Case, Christine L.- Pearson- 2018 - p. 964

6. Jenni Punt, Kuby IMMUNOLOGY\ Jenni Punt, Sharon A. Stranford, Patricia P. Jones, Judith A. Owen; by W. H. Freeman and Company, 2019 – p.1905

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

The time allocated for independent work can be used by students to:

preparation for lectures and laboratory classes;

preparation for exams and tests in the academic discipline;

solving clinical cases;

performing research and creative tasks;

preparation of thematic reports, abstracts, presentations;

performing test tasks;

taking notes of educational literature;

design of information and demonstration materials (posters, tables, newspapers, etc.);

production of laboratory teaching aids, multimedia audio and video materials;

compiling a thematic selection of literary sources and Internet sources;

drawing up tests for organizing mutual control

TOPIC FOR INDEPENDENT STUDY BY STUDENTS

Methods for microbiological diagnosis of rickettsial infections

Classification of rickettsia and rickettsioses. Causative agents of typhus and Brill-Zinsser disease, endemic rickettsioses. Ecology of rickettsiae, resistance. Hosts and carriers. Obligate intracellular parasitism of Rickettsia. Laboratory diagnosis of rickettsioses. Specific prevention, etiologic therapy.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

The main forms of organizing managed independent work:

preparation and presentation of an abstract;
 giving a presentation;
 studying topics and problems that are not covered in lectures;
 taking notes from primary sources (sections of anthologies, collections of documents, monographs, textbooks);
 computer testing;
 compiling tests for students to organize mutual control;
 production of didactic materials;
 preparation and participation in active forms of learning;

Control of supervised independent work is carried out in the form of:

tests;
 final lesson, colloquium in the form of an oral interview, written work;
 discussions of abstracts;
 protection of educational assignments;
 assessments of oral responses to questions, messages,
 checking abstracts, written reports;
 checking abstracts of primary sources, monographs and articles;
 individual conversation.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:

Oral form:

interview;
 exam;
 credit.

Written form:

written lab report;
 quiz.

Oral and written form:

laboratory reports with their oral defense.

Technical form:

tests.

LIST OF AVAILABLE TEACHING METHODS

Traditional method (lecture, laboratory practicals);

Active (interactive) methods:

- Problem-Based Learning;
- Team-Based Learning;
- Case-Based Learning;
- Research-Based Learning.

LIST OF PRACTICAL SKILLS

1. Preparation of a smear from an agar culture of bacteria.
2. Preparation of a smear from a broth culture of bacteria.
3. Staining the smear with magenta.
4. Stain the smear with methylene blue.
5. Microscopy of smears using an immersion system.
6. Gram staining of smears.
7. Identification by staphylococcus smear.
8. Identification by smear of streptococcus.
9. Identification by smear of gram-negative rod-shaped bacteria.
10. Identification by smear of bacilli.
11. Identification of encapsulated bacteria by smear.
12. Detection of gonococcus in a smear of pus.
13. Microscopic examination of sputum smears stained by Ziehl-Neelsen to identify mycobacteria.
14. Identification by smear of candida.
15. Identification by smear of corynebacteria stained according to Leffler.
16. Inoculation of pathological material on plate meat-extract agar (MPA) to obtain a pure culture of bacteria.
17. Indication of the type of colonies of a pure culture of bacteria grown on a plate MPA.
18. Reseeding of part of an isolated colony of a pure culture of bacteria from a plate MPA to a slant MPA.
19. Determination of the sensitivity/resistance of a bacterial culture to antibiotics using the disk diffusion method (algorithm and recording).
20. Setting up and taking into account the approximate agglutination reaction on glass.
21. Accounting for the indirect hemagglutination reaction.
22. Accounting for the agglutination reaction in test tubes to determine the antibody titer.
23. Accounting for the radial immunodiffusion reaction according to Mancini.
24. Taking into account the hemagglutination inhibition reaction for the identification of influenza viruses and serodiagnosis of viral infection.
25. Accounting for enzyme immunoassay.
26. Accounting for polymerase chain reaction.

LIST OF EQUIPMENT USED

1. Light immersion microscope;
2. dark-field microscope;
3. fluorescent microscope;
4. thermostat;
5. tablet spectrophotometer;
6. computers/tablets (computer lab);
7. multimedia projector;
8. TV;

9. ovoscope;
10. alcohol lamps;
11. bacteriological loops;
12. pipette dispensers;
13. laboratory glassware (Petri dishes, test tubes);
14. culture media;
15. set of Gram stains, reagents.

LIST OF LECTURES

4 semester

1. Microbiology as a science. The world of microorganisms Systematics, nomenclature and classification of microorganisms. Physiology of microorganisms.
2. Ecology of microorganisms. Fundamentals of the doctrine of infection. Microbiological basis of antimicrobial chemotherapy.
3. Sanitary and bacteriological research methods. Microbiological examination of medicinal raw materials and finished dosage forms.
4. Immunology. The immune system. Innate immunity.
5. Humoral and cellular immune response.

5 semester

1. General virology. Viral infections. Antiviral immunity. Chemotherapy and chemoprophylaxis of viral infections.
2. Orthomyxoviruses. Paramyxoviruses. Coronaviruses. Adenoviruses. Rubivirus. Parvoviruses. Herpes viruses. Ecological group of arboviruses and reoviruses.
3. Picornaviruses, reoviruses, noroviruses, hepatitis viruses A, E, B, C. Retroviruses, rhabdoviruses, poxviruses, polyoma- and papillomaviruses. Oncogenic viruses. Etiology of slow infections. Prions and prion diseases.

LIST OF LABORATORY CLASSES

4 semester

1. Morphology of microorganisms. Basic forms of bacteria. Bacterioscopic research method. Simple staining methods.
2. Bacterioscopic research method. Structure of a bacterial cell. Complex staining methods. Features of morphology and methods for studying spirochetes, rickettsia, chlamydia, mycoplasmas.
3. Physiology of microorganisms. Cultural (bacteriological) research method. Methods for isolating pure bacterial cultures.
4. Cultural (bacteriological) research method. Methods for identifying pure bacterial cultures.
5. Genetics of microorganisms. Methods for studying the genetics of bacteria. Genetics methods.
6. Ecology of microorganisms. Methods for studying the normal microflora of the human body. Fundamentals of the doctrine of infection.
7. Microbiological basis of antimicrobial chemotherapy. Methods for studying the sensitivity of microbes to antibiotics.

8. Antimicrobial measures: methods of sterilization and disinfection, antiseptics. Asepsis.

9. Sanitary and bacteriological research methods. Microbiological examination of plant raw materials and finished dosage forms.

10. Final class: «General and sanitary microbiology».

11. Immunology. The immune system. Innate immunity.

12. Antigens. Antibodies.

13. Humoral and cellular immune response.

14. Immunodiagnostics. Serological and cellular reactions.

15. Methods of clinical and infectious immunology. Allergy.

16. Anti-infective immunity. Immunoprophylaxis and immunotherapy of infectious diseases. Immunoprophylaxis and immunotherapy of infectious diseases.

17. Immune status of the body. Immunodeficiency states. Autoimmune diseases. The concept of immunocorrection.

18. Final class: «Theoretical and applied immunology».

5 semester

1. Methods for microbiological diagnosis of wound infections and purulent-inflammatory processes caused by *Staphylococci*, *Streptococci*, *Pseudomonas aeruginosa*.

2. Methods for microbiological diagnosis of wound infections and purulent-inflammatory processes caused by *Proteus*, *Bacteroides*, *Clostridias*.

3. Methods for microbiological diagnosis of meningococcal infection, whooping cough, diphtheria.

4. Methods for microbiological diagnosis of diseases caused by pathogenic mycobacteria, hemoglobinophilic (hemophilic) bacteria, *Klebsiella*, *Nocardia*, *Actinomyces*.

5. Methods for microbiological diagnosis of bacterial intestinal infections caused by enterobacteria.

6. Methods for microbiological diagnosis of bacterial intestinal infections caused by *Vibrio cholerae*, *Clostridia botulinum*, *Campylobacter*, *Helicobacter*, *Listeria*.

7. Methods for microbiological diagnosis of sexually transmitted infections.

8. Methods for microbiological diagnosis of bacterial zoonotic infections.

9. Fundamentals of medical mycology and protozoology.

10. Final class: «Medical microbiology».

11. General virology. Methods of virological research.

12. Methods for virological diagnosis of respiratory infections caused by orthomyxoviruses, paramyxoviruses, coronaviruses, adenoviruses, rubiviruses, parvoviruses.

13. Methods for virological diagnosis of diseases caused by herpes viruses, arboviruses and viruses with natural focality.

14. Methods for virological diagnosis of diseases caused by picornaviruses, reoviruses, noroviruses, hepatitis viruses A, E, B, C.

15. Methods for virological diagnosis of diseases caused by retroviruses, rhabdoviruses. Etiology of slow infections. Prions and prion diseases.

16. Methods for virological diagnosis of diseases caused by poxviruses, polyoma and papilloma viruses. Oncogenic viruses.

17. Final test: «General and medical virology».

PROTOCOL OF CURRICULUM APPROVAL

Name of the academic discipline with which approval is required	Department name	Proposals for changes in the content of the curriculum of a higher education institution in an academic discipline	The decision made by the department that developed the curriculum (indicating the date and protocol number)
Module «Pharmaceutical chemistry and pharmacognosy»	Pharmaceutical chemistry. Pharmaceutical technology.	There are no proposals to change the curriculum	09.29.2022, protocol N4
Module «Drug Development and Standardization»	Pharmaceutical chemistry. Pharmaceutical technology.	There are no proposals to change the curriculum	09.29.2022, protocol N 4

COMPILERS:

Head of the Department of Microbiology, Virology, Immunology, of the educational institution «Belarusian State Medical University», PhD, Associate Professor

T.A.Kanashkova

Associate Professor of the Department of Microbiology, Virology, Immunology of the educational institution «Belarusian State Medical University», PhD, Associate Professor

T.G.Adamovich

Associate Professor of the Department of Microbiology, Virology, Immunology of the educational institution «Belarusian State Medical University», PhD, Associate Professor

D.A.Charnashei

Associate Professor of the Department of Microbiology, Virology, Immunology of the educational institution «Belarusian State Medical University», PhD, Associate Professor

A.Yu.Kirylchyk

Curriculum content, composition and the accompanying documents comply with the established requirements.

Dean of the Medical Faculty for International Students of the educational institution «Belarusian State Medical University»

13. 11. 2023

O.S.Ishutin

Methodologist of the educational institution «Belarusian State Medical University»

13. 11. 2023

S.V.Zaturanova