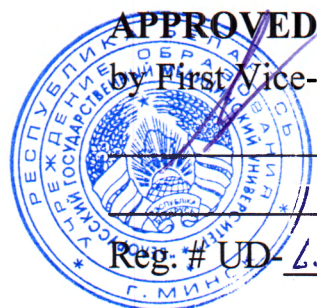


**MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS**  
Educational Institution  
**BELARUSIAN STATE MEDICAL UNIVERSITY**

Контрольный  
экземпляр



**APPROVED**

by First Vice-Rector, Professor

I.N.Moroz

16.11.2022

Reg. # UD-L.734/2223/edu.

**MICROBIOLOGY, VIROLOGY, IMMUNOLOGY**

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

**1-79 01 01 «General Medicine»**

Curriculum is based on the educational program «Microbiology, Virology, Immunology», approved 16.11.2022, registration # УД-Л.734/2223/уч.; on the educational plan in the specialty 1-79 01 01 «General Medicine», approved 18.05.2022, registration # L 79-1-1/2223 mf.

### **COMPILERS:**

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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 29.09.2022);

by the Scientific and Methodological Council of the educational institution «Belarusian State Medical University»  
(protocol # 9 of 16.11.2022)

## EXPLANATORY NOTE

«Microbiology, Virology, Immunology» – the academic discipline of the medical-prophylactic module, which contains systematized scientific knowledge about pathogenic and indigenous microorganisms, etiology, mechanisms of pathogenesis, laboratory diagnostic methods for bacterial, viral, fungal infections and protozoal invasions, specific prevention, etiotropic therapy, as well about the structure and the function of the human immune system, methods and tools for the diagnosis, treatment and prevention of diseases based on the immune system function impairment and/or immunological mechanisms.

The aim of the discipline «Microbiology, Virology, Immunology» is the formation in students of basic professional competencies in the field of theoretical and applied knowledge of the etiology, mechanisms of pathogenesis, methods of laboratory diagnostics, prevention, the basics of epidemiology and etiotropic therapy of human infectious and parasitic diseases; about the structure, development, methods of assessment and correction of the human immune system, necessary to solve problems in the professional activity of a physician.

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

- place and role of microorganisms in the biosphere;
- principles of taxonomy and nomenclature of microorganisms;
- microbial sensitivity and resistance to environmental factors and methods of sterilization, disinfection, asepsis, antisepsis, necessary for medical specialist;
- morphology, physiology, genetics, ecology and evolution of microorganisms;
- general regularities of occurrence and conditions for the development of bacterial, viral, fungal and protozoal infections;
- pathogenicity factors of microorganisms, pathogens and mechanisms of the molecular pathogenesis of human infectious diseases;
- opportunistic pathogens and opportunistic infections;
- main groups of antimicrobial chemotherapeutic drugs and their mechanisms of action on microorganisms;
- mechanisms of microbial resistance formation to antimicrobial medicines and methods of its determination;
- structure and mechanisms of functioning of the human immune system;
- humoral and cellular types of the immune response, anti-infection immunity regularities;
- immunopathogenesis of allergic, infection-allergic, and autoimmune diseases, immunodeficiencies and immunocorrection principles;
- skills and abilities necessary for:
  - working safely with biological material and live cultures of microorganisms:
  - biological material samples collection, labeling and direction for research;
  - performance of microbiological, immunological and molecular methods for bacterial, viral, fungal and protozoal diseases diagnosis;
  - interpretation of the microbiological and immunological studies results.



The knowledge, skills, and abilities acquired during the study of the academic discipline «Microbiology, Virology, Immunology» are necessary for successful mastering the following academic disciplines: «Epidemiology», «Dermatovenereology», «Phthisiopulmonology», «Internal Diseases», «Clinical Immunology, Allergology», «Infectious Diseases», «Pediatric Infectious Diseases».

Student mastered the educational discipline «Microbiology, Virology, Immunology» should have the following basic professional competency:

BPC. Apply knowledge about the main characteristics of microorganisms causing human infectious diseases, the patterns of the immune system functioning, the mechanisms of disease development in case of microbiological assessment.

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

**know:**

the principles of systematics and nomenclature of microorganisms;  
 morphology, physiology, genetics, antigenic structure, ecology of bacteria, viruses, fungi, protozoa, basics of biotechnology and genetic engineering;  
 the impact of environmental factors on microorganisms, biosafety classes of microorganisms, microbiological bases of antimicrobial measures;

main groups of antimicrobial drugs. Antiseptics, mechanisms of action, mechanisms of formation and methods of control of resistance to antimicrobials;

normal microflora of the human body, its formation and biological role; dysbiosis, reasons of development and correction principles;

pathogenicity factors and their genetic control;  
 etiology, mechanisms of molecular pathogenesis, microbiological, immunological and molecular-biological methods of diagnosis, basics of causal treatment and immunoprevention of infections and protozoan invasions;

human immune system, mechanisms of innate and acquired immunity, immunopathogenesis of allergic, infection-allergic, and autoimmune diseases, immunodeficiencies, bases of antitumor immunity;

immune status, age peculiarities, methods of assessment;  
 the rules of sampling, labeling and transportation of biological material to the laboratory for bacteriological, virological, immunological and molecular studies;

**be able to:**

to fill in forms for microbiological, immunological and molecular research;  
 to determine the sensitivity of bacteria to antibiotics by disc- diffusion method;  
 to carry out the agglutination test, passive hemagglutination test, latex agglutination test, fluorescent antibodies test, enzyme immunoassay, immunochromatographic analysis;

to assess and analyze the parameters of an immunogram;  
 to assess the results of bacteriological, immunological and molecular-genetic researches;

**master:**

skills of safe work with biological materials and microbial cultures;



modern methods of decontamination of biological materials and environmental objects;

techniques of microbiological smears preparations and staining with simple methods and Gram method;

techniques of immersion light microscopy with the results evaluation;

technique of biological material primary inoculation on a nutrient medium for the isolation of pure cultures of bacteria.

**Total number** of hours for the study of the discipline is 228 academic hours. Classroom hours distribution according to the types of studies: lectures - 36 hours (including 12 hours of supervised student independent work), practical classes - 105 hours, student independent work (self-study) - 87 hours.

Intermediate assessment is carried out according to the educational plan 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	practicals		
<b>1-79 01 01 «General Medicine»</b>	4	108	69	18	6	51	39	credit
	5	120	72	18	6	54	48	examination
		<b>228</b>	<b>141</b>	<b>36</b>	<b>12</b>	<b>105</b>	<b>87</b>	

## THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	practicals
<b>1. General microbiology</b>	<b>6</b>	<b>24</b>
1.1. Microbiology as a science. The world of microbes	1	–
1.2. Morphology of microorganisms	–	6
1.3. Physiology of microorganisms	1	4
1.4. Genetics of microorganisms	2	2
1.5. Ecology of microorganisms		3
1.6. Fundamentals of infectology	2	3
1.7. Microbiological basics of chemotherapy and antiseptics of bacterial infections		6
<b>2. Theoretical and applied medical immunology</b>	<b>8</b>	<b>24</b>
2.1. Immunology as a science. Immune system	2	1
2.2. Innate immunity		2
2.3. Immune response	2	4
2.4. Allergy and ecological immunology	1	2
2.5. Anti-infection immunity	1	1
2.6. Immunodiagnostics of infectious diseases	–	6
2.7. Immunoprophylaxis and immunotherapy of infectious diseases	1	2
2.8. Basics of clinical immunology	1	6
<b>3. Special medical microbiology</b>	<b>12</b>	<b>33</b>
3.1. Gram-positive cocci	1	2
3.2. Neisseria	1	1
3.3. Aerobic and facultative anaerobic gram- negative rods	3	9
3.4. Aerobic and facultative anaerobic gram-positive bacteria	2	3
3.5. Ecological group of anaerobic bacteria	1	3
3.6. Causative agents of especially dangerous and highly contagious infections	–	3
3.7. Spirochetes	1	3
3.8. Rickettsia, chlamidia, mycoplasm	1	6
3.9. Fundamentals of medical mycology	1	2
3.10. Basics of medical protozoology	1	1
<b>4. General and special medical virology</b>	<b>8</b>	<b>18</b>
4.1. General virology	2	3
4.2. RNA-genomic viruses	2	6
4.3. DNA-genomic viruses	2	2
4.4. Hepatitis viruses		1
4.5. Ecological group of arboviruses and reoviruses	2	2
4.6. Oncogenic viruses		4
<b>5. Clinical microbiology</b>	<b>2</b>	<b>6</b>
<b>Total hours</b>	<b>36</b>	<b>105</b>



## CONTENT OF THE EDUCATIONAL MATERIAL

### 1. GENERAL MICROBIOLOGY

#### 1.1. Microbiology as a science. The world of microbes

***Subject, problems, methods and place of microbiology in the systems of sciences.*** Microbiology as a complex of sciences about morphology, physiology, ecology, genetics and evolution of microorganisms. Classification of microbiological sciences: on object of research (the general microbiology, bacteriology, virology, mycology, protozoology), on the applied purposes (medical, sanitary, veterinary, technical, soil, sea, space).

Medical microbiology as a science about microorganisms important for human health, etiology, pathogenesis, diagnosis, etiotropic therapy and specific prevention of diseases caused by them. Value of microbiology for the progress of sciences about the nature and human society, in the development and implementation of a system of measures to improve the human health. Problems of medical microbiology. Microbiological research methods: microscopic, cultural, immunobiological (serological, cellular, allergological, etc.), molecular, experimental. Connections of medical microbiology with biological, biomedical, clinical, hygienic and human sciences.

Microbiology place in the public health system and principles of the microbiological and immunological services organization. The role of medical microbiology in the professional activity of a medical specialist.

***Microbiology history.*** Early knowledge about organisms invisible to the naked eye – contagium (I century BC – I Roman century AC –encyclopedists; XVI century – D. Frakastoro; XVII century - A. Kirher).

The invention of a microscope and discovery of the microbial world by A. Leeuwenhoek. Foundation of scientific microbiology in the second half of XIX century L. Paster - the founder of technical and medical microbiology, the founder of the doctrine about immunoprophylaxis of infectious diseases. R. Koch's role in working out of microbiological methods of research, discovery of causative agent of tuberculosis and cholera.

The importance of the Henle-Koch triad in accepting the microorganism as the causative agent of the infectious disease. Doctrine creation about cellular (I.I. Mechnikov) and humoral (P. Ehrlich) immunity. The discovery of viruses (D.I. Ivanovski) and its value for the biology and medicine. S.N. Vinogradski role in the origin and development of soil microbiology. Working out of principles of antiseptics (I. Zemmelvejs, D. Lister) and chemotherapy (D.L. Romanovsky, P. Ehrlich) of bacterial infections. The basic directions of microbiology development in XX and XXI centuries. Microbiology development in Belarus.

Systematics and nomenclature of microorganisms. A place of microorganisms in the organic world. Common with animals and plants and specific features of microorganisms.

Principles and approaches to systematization and the nomenclature of microorganisms. Phenosystematics. Genosystematics. Applying DNA and 16s rRNA for taxonomy. The mixed approach to systematization. Taxonomic categories: the

domain, type (department), class, order, family, genus, species. Subspecies categories: variant, strain, culture, clone. Species as the basic taxonomy category. Criteria of a species in microbes.

Classification of microorganisms. Prokaryotes (bacteria) and eukaryotes (fungi, protozoa) organisms. Viruses, viroids and prions.

The international principles and rules of the microorganism's nomenclature.

**Evolution of microorganisms.** An origin and development of microbes. Evolution factors. Morphological, biochemical and ecological evolution of microbes during biosphere formation. The subsequent evolution of microbes. Sources and time of pathogenic microorganisms emergence. The basic directions and driving factors of microbe's evolution during the modern period.

## 1.2. Morphology of bacteria

**Morphology of bacteria.** Forms and size of bacteria. The structure of a bacterial cell. Features of the chemical composition of bacteria compared to eukaryotic organisms. Nucleoid. Plasmids. Ribosomes. Inclusions. A cytoplasmic membrane, mesosomes. Periplasmic space. The cell wall of Gram-positive and Gram-negative bacteria. Capsule. Flagella. Pili. Sex-pili. Cell wall defective forms of microbes (protoplasts, spheroplasts, L-forms).

**Methods of bacteria morphology research.** The microscopic method, task, steps, advantages and disadvantages. Types of microscopic preparations. Technics of fixed and native smears preparation. Microscopy of preparations with a light microscope and its variants: bright field, dark field, phase contrast, luminescent. Technics of light microscopy. Studying microorganism's morphology in an electronic microscope. Tinctorial properties of microbes. Dyes. Simple and differential methods of fixed preparations staining. Technics of staining by Gram, Ziel-Nielsen, Ozheshko, Burri-Gins, Neisser, Romanovsky-Giemsa. Methods for alive microorganism's research.

**Morphology of Actinomyces, Spirochetes, Rickettsia, Chlamydia, Mycoplasma.** Main forms, ultrastructure, methods of studying.

## 1.3. Physiology of microorganisms

**Metabolism and energy exchange in microorganisms.** Features of a metabolism and energy exchange in microbes. Enzymes of microbes, classification. Types of bacterial secretory systems.

Holozoic and holophytic nutrition.

**A nutrition in bacteria.** Nutrients - sources of carbon and nitrogen, oxygen, hydrogen. Autotrophs and chemoorganotrophs. Factors of growth and their sources. Sources of mineral elements. Extracellular digestion of polymers. Ways and mechanisms of nutrient transfer across the cell wall and cytoplasmic membrane of a bacterial cell.

**Respiration in bacteria.** Energy needs of bacteria. The respiratory apparatus of bacteria. Ways of energy production in autotrophs (photosynthesis, chemosynthesis). Sources and ways of energy production in chemoorganotrophs. Biological oxidation. Aerobic and anaerobic types of biological oxidation in bacteria. Aerobic, anaerobic, facultatively anaerobic and microaerophilic bacteria. Capnophiles.



Features of a metabolism and energy exchange in Rickettsia, Chlamydia, Mycoplasma. Basics of Biotechnology.

***Growth and reproduction of microorganisms.*** Ways of reproduction. Binary (simple, isomorphic) fission, mechanism. Schizogony. Budding. Sporulation. Growth and reproduction conditions, regulation mechanisms. Reproduction of bacterial populations. Periodic and continuous bacterial cultures. Features of reproduction of Rickettsia, Chlamydia, Mycoplasma. Resting forms of microorganisms, their properties and significance.

***Bacteriological (cultural) research method.*** Principles and methods of bacteria culturing. Nutrition requirements of microbes. Nutrient media for bacteria. Requirements to nutrient media. Classification of nutrient media. Conditions and technics of bacteria culturing. Regularities and character of bacterial growth on solid and liquid nutrient media.

Problems, steps, advantages and disadvantages of a bacteriological method. Rules of sampling and transportation of investigated material. Technics of culture medium inoculation. Methods for isolation and identification of pure culture of aerobic and anaerobic bacteria. Automatic microbiological analyzers, principles of operation. Time-of-flight mass spectrometry (MALDI-TOFF MS) for bacteria identification.

Features of Rickettsia, Chlamydia, Mycoplasma culturing.

#### **1.4. Genetics of microorganisms**

***Heredity.*** Value of microbiology in development of molecular genetics. The organization of the genetic apparatus in bacteria (nucleoid, plasmids, Is-sequences, transposons, integrones). Principles of bacterial genome functioning. Operone organization. A genotype and a phenotype. CRISPR/Cas9 - genome editing technology.

Genomics of microorganisms. Proteomics of microorganisms.

***Variability of microbes.*** Modifications in bacteria, value, the basic characteristics (not hereditary character, adaptability, high frequency of direct and return changes, inducing factors). Genotypic variability. Mutations and their classification. Mutagens. Phenotypic manifestations of mutations. Transposition. Dissociation in bacteria. System of genome damages reparation. Recombinational variability. Mechanisms of combined genome formation. Frequency of changes of separate attributes. Transformation, transduction, conjugation, transposition. The fate of mutants and recombinants. Selective influence of discriminative factors.

***Methods of the genetic analysis.*** Practical value of knowledge about microbes' genetics. Principles of genetic mapping. Molecular hybridization, polymerase chain reaction (PCR), blotting, sequencing. The value of genetic methods in laboratory diagnosis of infectious diseases and epidemiological analysis.

Concept of genetic engineering and use of the methods in microbiology and biotechnology. Creation and application of gene-engineered vaccines and cytokines.

#### **1.5. Ecology of microorganisms**

Separation of ecological microbiology into an independent section (S.N. Vinogradsky, 1945). Value of microbes in formation, existence and development of the Earth's biosphere. The concept of a microbic dominant.

Microbiological aspects of environment protection. Ecological niches of microbes. Soil microflora. Water microflora. Microflora of an open air and air of premises. Microflora of anthropogenic environments (objects, food, medicines, medical devices, etc.). Criteria for microbiological safety of the human environment. Sanitary-indicative microorganisms.

Ecological interactions of microbes (symbiosis, commensalism, neutralism, competition, parasitism, predatoriness). Influence of ecological factors on microbes.

Effect of physical (temperature, drying, radiations, ultrasound, osmotic pressure) and chemical factors.

***Antimicrobial measures.*** Sterilization, disinfection, asepsis, definition of concepts. Purposes, methods, means and objects for sterilization and disinfection in medicine and microbiology. Sanitary and anti-epidemic regimen in healthcare organizations.

***Microflora of a human body.*** Normal (resident) microflora. Autochthonous and allochthonous, parietal and luminal microflora. The concept of microbiota. Formation and development of normal microflora. Species and quantitative structure of normal microflora of distinct biotopes of a human body. The role of normal microflora: antiinfection, metabolic, immunobiological, antitoxic. Biofilms. Colonization resistance. Quorum sensing.

The factors influencing structure of normal microflora. Dysmicrobiocenosis (dysbacteriosis), the reasons, types, correction principles. Preparations for restoration of microflora. The role of normal microflora in infectious processes, conditions of manifestation. Methods for studying human microflora. Gnotobiology. Human microbiome, metagenomic approach to study.

## **1.6. Fundamentals of infectology**

***Infection (infection process) and invasion:*** definition, general characteristics. Differences between infectious and non-infectious diseases. The history of ideas about the causes of infectious diseases. Miasmatic (Hippocrates) and contagious (Varro, Fracastoro, Pliny) hypothesis, monocausalism (R. Koch). Causes and conditions for the infectious process.

The role of microorganisms in the infectious process. The infectious dose. Ways of infection. Entrance gate. Pathogenicity. Virulence. Heterogeneity and variability in virulence in microbial populations. Genetic control of pathogenicity and virulence. Pathogenicity islands. Factors that increase and decrease the virulence of bacteria. Pathogenicity factors. Adhesins. Colonization factors. Invasins. Factors that suppress the immune system of the host. Exotoxins, endotoxins, enzyme-toxins, heat shock proteins, their properties. Types of bacterial exotoxins, targets and mechanisms of action. Methods for determination of pathogenicity factors. Intracellular pathogens. Pathogenic, opportunistic and nonpathogenic microbes.

The role of the macroorganism in the development of infectious diseases. Hereditary factors. Anatomical and physiological condition of the body, lifestyle. The role of living conditions in the development of infectious diseases, the influence of natural and social factors.



The evolution of infectious diseases, positive and negative changes in infectious pathology in the second half of the 20<sup>th</sup> and early 21<sup>st</sup> centuries. The concept of emerging infections and global epidemiological surveillance.

Classification of infectious processes: by severity (carrier state, asymptomatic infection, infectious disease); by nature of the pathogen (bacterial, viral, prion, fungal, protozoan); by source of infection (anthroponoses, zoonoses, sapronoses); by the mechanism of transmission and routes of infection (aerosol, fecal-oral, contact, transmissible, transplacental, exo-, endo-, autoinfection); by the prevalence and intensity of the epidemic process (ubiquitous, endemic, pandemic, epidemic, sporadic infections); by localization (local, systemic (respiratory, gastrointestinal, urogenital, skin, nervous system), generalized infection (bacteremia, toxemia, septicemia, septicopyemia, bacterial shock); by duration (acute, subacute, chronic, slow infection); by the multiplicity of infection (primary, secondary, mixed infection, superinfection, reinfection, relapse).

**Biological (experimental) research method:** tasks, steps, advantages, disadvantages. Laboratory animals. Methods of infection. Application for isolation and identification of the causative agent, assessment of virulence, toxicity and toxigenicity of microbial cultures, immunogenicity, sterility, biosafety, pyrogenicity.

### **1.7. Microbiological basics of chemotherapy and antiseptics of bacterial infections**

**Chemotherapy and chemoprophylaxis:** definition, place in the therapeutic and anti-epidemic measures. History of chemotherapy. Empirical period. Establishment of the doctrine of chemotherapy (D.L. Romanovsky, 1882; P. Erlih, 1906). Implementation of sulfonamides in the practice of therapy (G. Domagk, 1936), antibiotics (A. Fleming, 1926, X. Florey, E. Chain, 1940; Z.V. Ermoleva, 1942), nitrofurans (M. Dodt, W. Stillman, 1944). Modern directions in chemotherapy development: the search for natural compounds, chemical synthesis and modification, improvement of application schemes. Principles of rational chemotherapy, peculiarities in children and elderly.

**Antimicrobial agents:** properties, requirements, etiotropic and organotropic features, chemotherapeutic index. The concept of selectivity and «targets» of antimicrobial drugs action, the effect and spectrum of action, mechanisms of action on microorganisms.

Side effects of chemotherapy: dysbacteriosis, disease exacerbation, secondary infection, the negative organotropic effect (toxic, allergenic, teratogenic, mutagenic, carcinogenic).

The main groups of antimicrobial drugs: sulfonamides, azoles, quinolones, nitrofurans, fluoroquinolones, oxazolidinones and others.

**Antibiotics,** definition. Natural producers of antibiotics. Synthetic and semi-synthetic antibiotics. The main groups of antibiotics: beta-lactam (penicillins, cephalosporins, carbapenems, monobactams), aminoglycosides, tetracyclines, macrolides and azalides, lincosamides, chloramphenicol, ansamycins (rifamycins), polymyxins, cyclopeptides, glycopeptides, lipopeptides, streptogramins, polyenes.

Bacterial resistance to antimicrobial drugs. Natural resistance. Acquired resistance, its genetic and biochemical mechanisms. The role of plasmids and

transposons in the emergence and spread of multidrug-resistant strains. Extreme and total resistance to antimicrobial drugs. The concept of international clones of microorganisms with a high epidemic risk.

Indicators and methods for determining the sensitivity (resistance) of bacteria to antibiotics. Technics of performance and evaluation of the disk-diffusion method. Epsilometric method (E-tests). Method of antibiotics serial dilutions in liquid and solid nutrient media. Sensitivity interpretation using thresholds for minimum inhibitory concentrations and inhibition zone diameters. Devices and test systems for automated determination of antibiotic sensitivity. Molecular genetic methods (PCR).

**Antisepsis**, definition, types (preventive, therapeutic). Categories of preventive antiseptics. Antiseptics (chemical, biological, physical, mechanical).

Chemical antiseptics: requirements, origin, properties, groups, mechanisms of action on microorganisms.

## **2. THEORETICAL AND APPLIED MEDICAL IMMUNOLOGY**

### **2.1. Immunology as a science. Immune system**

Immunology as a science: definition, history of foundation and development (E. Jenner, L. Pasteur, I.I. Mechnikov, P. Ehrlich, K. Landsteiner, F. Bernet, S. Tonegava, Ch. Janeway, P. Matzinger). The main sections of modern immunology. Immunology role in the development of biology and medicine. Problems of medical immunology, its value for practical medicine.

**Immune system.** Immunocompetent organs (central and peripheral): structure, function, changes in ontogeny. Immunocompetent cells: types, morphology, CD-markers, identification methods. Major histocompatibility complex (MHC). Molecule I, II and III classes of MHC, structure, expression on cells and tissues. The biological significance of MHC molecules, role in recognition and elimination of antigens. Factors of intercellular interaction in the immune system (the selectins, integrins, immunoglobulin superfamily molecules).

Pattern recognition receptors. Toll-like receptors.

Cytokines: classification (interleukins, interferons, growth factors, chemokines), characteristics, structure, function, receptors.

Pro-inflammatory cytokines. Cytokines – regulators of hematopoiesis. Interferon system, classification, structure, function.

The protective function of the respiratory, digestive, endocrine and other systems of the human body. Cooperative mode of an immune system functioning.

### **2.2. Innate immunity**

Definition. Characteristics. Non-immune mechanisms of natural immunity: barrier and antimicrobial properties of the skin, mucous membranes, lymph nodes, tissue unresponsiveness, normal microflora and others. Immune factors: humoral and cellular factors of innate immunity. The complement system, structure, activation pathways (classical, alternative, lectin). Activators of the complement system. Inhibitors of the complement system. Complement receptors, expression on cells, function. Biologically active fragments of complement proteins and their functions. Anaphylatoxins. The membrane attack complex. Methods for the activity of complement system assaying. Lysozyme. Acute-phase proteins. Natural antibodies.



Polymorphonuclear and mononuclear phagocytes (origin, characteristics, functions). Phagocytic reaction (phase, factors and mechanisms of intracellular killing). Phagocytosis outcomes. Persistence of bacteria in phagocytes. Phagocytosis indices and methods for evaluation. Principles of recognition and response in innate immunity system Toll-dependent signaling pathways of phagocytes activation. Activated macrophages and the regulation of their functions. Neutrophil extracellular traps.

Natural killer cells, the mechanism of damage to the target cells.  $\gamma\delta$ -T-lymphocytes.

### **2.3. Immune response**

Definition, the types of the immune response. Primary and secondary immune response. Immunological memory. Relationships and interactions between innate and acquired immunity.

**Antigens:** structure, properties, classification. Adjuvants. Antigenic structure of bacteria: O, H, K, fimbrial, cytoplasmic, membrane, extracellular antigens (toxins and exoenzymes). Group, species, typical antigens. Antigenic variation. Cross-reacting antigens. Antigenic mimicry. Antigens of viruses, fungi and protozoa. T-dependent and T-independent antigens. Superantigens: structure, function.

**Antigen-presenting cells (APC):** the types and characteristics. APC interaction with antigen: antigen processing and presentation, APC activation.

**B-lymphocytes:** development, markers. B-cell receptor: structure, constant and variable regions. Mechanisms of B-cell activation. The function of B-lymphocytes. Methods for assaying of B-lymphocytes amount and functional activity.

**Humoral immune response:** the dynamics of development, manifestation. Primary and secondary immune response, switching of immunoglobulin classes, affinity maturation.

**Antibodies.** The structure of immunoglobulin molecules: variable and constant regions, the location and structure of the domains, the antigen and complement-binding regions. Classes and subclasses of immunoglobulins, isotypes, allotypes, idiotypes. Biological properties of the immunoglobulins. Biosynthesis, specificity, and genetic control of humoral antibody diversity. Immunoglobulin genes. The mechanism of interaction of antibodies with antigens. Valence, affinity and avidity of antibodies. Cross-reactions. Complete and incomplete antibodies. Immune complexes. Utilization of immune complexes. Biological effects of the interaction of antibodies with antigens: activation of the complement, toxins and viruses neutralization, lysis, agglutination and opsonization of microorganisms, inhibition of adhesion, invasion. Transport of antibodies into tissues, regulation of the synthesis (quantity) of antibodies.

**T-lymphocyte:** development, markers. Subpopulations of T-lymphocytes (helper T cells: T-helper 1, 2 and other types, T-regulators, cytotoxic T-lymphocytes, memory T-lymphocytes). T-cell receptor: structure, types, genetic control, diversity. T-cell epitopes. T-cell restriction (MHC molecules, CD4/CD8). T-lymphocyte activation: a model of two signals, the role of the T-cell receptor, costimulatory interactions (CD28–CD80/86, CD40–CD40L, ICOS–ICOSL, PD–PDL, CD28–

CTLA4), cytokines, hormones. Anergy, apoptosis. Methods for assaying the amount and functional activity of T- lymphocytes.

**Cellular immune response:** the dynamics of development, manifestation. T-dependent effector and regulatory mechanisms.

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

#### **2.4. Allergy and ecological immunology**

**Allergy,** definition. Allergens. Domestic, pollen, epidermal, food, chemical, pharmaceutical, microbial exoallergens. Routs for allergens entering the human body. Endoallergens. Stages of allergy development: sensitization, challenge, de- and hyposensitization. Role of T-helper cells type 1 and 2 and cytokines synthesized in the development of hypersensitivity. Types of allergic reactions. Hypersensitivity of immediate type (HIT). HIT of mediator type (I). Anaphylactic shock, the mechanism of development. Atopy: the mechanism of development, clinical forms. Cytotoxic (II) and immunocomplex (III) types: anemia, Goodpasture's syndrome, serum sickness, infection immunocomplex allergy. Delayed Type Hypersensitivity (DTH, IV). Contact allergy. Infection allergy. Drug allergy. Exudative erythema multiforme. Lyell's syndrome. Food allergy. Idiosyncrasy. Methods of allergic diseases diagnostics. Specific immunotherapy. Prevention of allergic diseases at the workplace, at home, in health care.

Molecular Allergology. Modern approaches to allergen classification, diagnosis and treatment of HIT type I.

**Ecological immunology:** definition, objects of study. Immunotropic environmental factors (IEF), natural and anthropogenic. Mechanisms and conditions of the IEF effect on the human immune system. Bioaccumulation and biodegradation of IEF in the environment and in the body. Range and immune mechanisms of adaptation to ecosystems with extreme conditions (the Arctic, desert). Ecoimmunological monitoring in the areas of working and living of people burdened by environmental conditions.

#### **2.5. Anti-infection immunity**

General regularities of anti-infection immunity development and basic protective mechanisms at different stages of the infectious agent interaction with the host. Immunity against extracellular and intracellular parasites. Mechanisms of immune inactivation of bacteria, fungi, protozoa, viruses and neutralization of their toxins and exoenzymes. The concept of natural and artificial, active and passive, systemic and local, post-infection and infection (non-sterile) types of immunity. Maternal (transplacental, trophic) immunity in newborns and infants: mechanisms, significance.

#### **2.6. Immunodiagnostics of infectious diseases**

**Serological method of investigation:** tasks, steps, evaluation. Diagnosticum, diagnostic antisera, methods of preparation. Polyvalent, monospecific adsorbed (polyclonal) and monoclonal diagnostic serum and test systems. Monoclonal antibodies: methods of production, application. Hybridoma biotechnology.

Quantitative evaluation of serological reactions, antiserum titer, diagnostic titer, increase in antibody titer, affinity. Types of serological tests. Agglutination



tests, indirect / passive hemagglutination, latex agglutination, immunoprecipitation: variants of performance, methods of results accounting, evaluation, application. Immune lysis reactions. Toxin neutralization test.

**Solid-phase immunoassay:** immunofluorescence reaction, immunoelectron microscopy (IEM), enzyme-linked immunosorbent assay (ELISA), immunochromatographic analysis (ICA) - the principles, variants of performance, results accounting, evaluation, application. Immunoblotting (Western blotting). Express tests.

## **2.7. Immunoprophylaxis and immunotherapy of infectious diseases**

**Immunoprophylaxis:** definition. Active immunoprophylaxis. Immunization schedule, concept. Vaccine, requirements: immunogenicity, safety, areactogenicity, stability, association. Types of vaccines: inactivated, live, toxoids, chemical, subunit, genetically engineered. Adjuvants. The main vaccines against bacteria, viruses, and parasites. New approaches to the creation of vaccines (vector vaccines, DNA vaccines, with MHC gene products, based on the principle of «reverse» vaccinology, etc.). Factors affecting the effectiveness of post-vaccination immunity associated with the vaccine (dose, interval, competition of antigens, duration of antigenic stimulation (“depot” principle), booster effect) and with the state of the human body (age, hormonal status, nutritional status, etc.). Dynamics of development and methods for assessing post-vaccination immunity. Protective antibody titer.

Passive immunoprophylaxis: definition, indications for use.

**Immunotherapy:** definition. Therapeutic and prophylactic immune sera and immunoglobulins: types and methods of production, activity determination.

Complications of immunization and immunotherapy.

## **2.8. Basics of clinical immunology**

**The immune status of an organism,** definition. Parameters, methods of determination and estimation of the immune status. Immunogram. Flow cytometry to assess immunocompetent cell subpopulations.

**Immunodeficiencies** (congenital and acquired): classification, mechanisms, clinical syndromes, principles of diagnosis and correction. Diagnosis/monitoring system for primary immunodeficiencies in the Republic of Belarus.

**Autoimmune diseases:** classification, mechanisms of damage to organs, cells and tissues, principles of diagnosis and treatment.

Autoantigens. Autoantibodies, the significance of assaying in clinical practice.

**Transplant immunity.** Types of transplants. Transplant antigens. Conditions of development of transplant rejection and its mechanisms. Methods for diagnosing and suppressing the transplant reaction, complications. Graft-versus-host reaction.

**Antitumor immunity.** The concept of immune surveillance. Characteristics of tumor antigens. Mechanisms of anti-tumor immunity. Mechanisms of tumor escape from immune surveillance. Immunodiagnostics and immunotherapy of tumors. Tumor markers.

**The concept of immune correction:** indications, means, methods, monitoring the effectiveness of immune correction. Immunotropic drugs: groups, mechanisms of action, areas of application. The use of the immunotropics in the treatment of

transplant rejection, autoimmune and allergic diseases. Immunotherapy of malignant neoplasms. Immunotherapy with monoclonal antibodies.

### 3. SPECIAL MEDICAL MICROBIOLOGY

#### 3.1. Gram-positive cocci

**Staphylococci:** systematic position, general characteristics, main species, sensitivity to environmental factors, resistance to chemotherapeutic drugs and antiseptics. Pathogenicity factors of staphylococci: alpha-toxin, exfoliative toxin, toxic shock syndrome toxin, enzyme-toxins, enterotoxins. Staphylococcal infections (purulent-inflammatory diseases, sepsis, occupational pyoderma, nosocomial infections), food intoxication, pathogenesis, immunity and methods of microbiological diagnostics. Toxic shock syndrome. Hospital ecovars of staphylococci: phage-, resistance-, genotyping. Methicillin-resistant *Staphylococcus aureus* (MRSA). Preparations for etiologic therapy of staphylococcal infections, antiseptics.

**Streptococci:** systematic position, general characteristics, classification by biological properties and antigenic structure. Pyogenic streptococci, properties, antigenic structure and serovars, sensitivity to environmental factors, pathogenicity factors (erythrogenic toxin, cross-reactive antigens, enzymes toxins, capsular substance). Etiology, pathogenesis, immunity, diagnostics, prevention of acute and chronic streptococcal infections (purulent-septic infections, sore throat, scarlet fever, rheumatic fever, chronic tonsillitis, glomerulonephritis, erysipelas, streptoderma). Antibodies to toxins and enzymes of streptococci and their role in immunity and diagnostic value. *Streptococcus pneumoniae*, properties, differentiation by capsular antigen, pathogenicity factors. Pneumococcal infection, pathogenesis, immunity, microbiological diagnostics. Invasive strains of pneumococcus as the causative agents of childhood purulent meningitis. Preparations for specific prevention and chemotherapy of pneumococcal infections.

The basics of *enterococci* and enterococcal infections.

#### 3.2. Neisseria

Systematic position, general characteristics. Pathogenic *Neisseria*. Gonococci: properties, differentiation by fimbrial antigens, sensitivity to environmental factors, pathogenicity factors. Prevalence, pathogenesis, immunity, diagnostics of gonorrhea and gonoblenorrhoea. Meningococci: properties, differentiation by surface antigen, sensitivity to environmental factors, pathogenicity factors. Pathogenesis and clinical forms of meningococcal infections, immunity, microbiological diagnostics, carrier state. Preparations for specific prevention and chemotherapy of meningococcal infection.

Prevention of gonoblenorrhoea in newborns.

#### 3.3. Aerobic and facultative anaerobic gram-negative rods

##### ***Bordetella and Hemoglobinophilic bacteria***

***Bordetella.*** The causative agent of whooping cough, properties, antigenic structure, sensitivity to environmental factors, pathogenicity factors, differentiation with the causative agent of parapertussis. Pathogenesis, immunity, microbiological diagnostics, immunoprevention of whooping cough, monitoring of immune population. Chemotherapy drugs for whooping cough.



*Hemoglobinophilic (hemophilic) bacteria. Haemophilus influenzae* and its role in the pathology of children and adults, pathogenicity factors. Microbiological diagnostics and specific prevention of *Hib*-infection.

***Legionella***: properties, antigenic structure, pathogenicity factors. Pathogenesis, clinical forms and microbiological diagnostics of legionellosis.

*Coxiella*, general characteristics. Etiology, pathogenesis, microbiological diagnostics of Q-fever.

***Enterobacteriaceae***: systematic position, general characteristics, classification, pathogenic and opportunistic species, role in human pathology. Acute intestinal infections: prevalence, etiology, pathogenesis.

*Escherichia*: classification, general characteristics. *E. coli*, morphological, cultural, biochemical properties, serological classification, sensitivity to environmental factors. Opportunistic *E.coli*, biological role. Opportunistic infections. Hospital ecovars. Obligate pathogenic (diarrheagenic) *E.coli*, pathogenicity factors, serovars. Prevalence, pathogenesis, clinical forms, microbiological diagnosis of escherichiosis.

*Salmonella*: general characteristics, taxonomy and serological classification, pathogenicity factors. Etiology, pathogenesis, immunity, microbiological diagnostics of typhoid and paratyphoid fever, carrier state, relapses. Phage typing and genotyping of *Salmonella*. Preparations for immunoprophylaxis and chemotherapy of typhoid fever.

Salmonellosis, properties of pathogens, prevalence, association with food intake, enteral, general toxic, septic syndromes, microbiological diagnostics, prevention. Nosocomial anthroponotic salmonellosis, pathogens, features of epidemiology, multiple resistance of the pathogens to antibiotics and antiseptics.

*Shigella*: general characteristics, classification, sensitivity to environmental factors, pathogenicity factors. Prevalence, pathogenesis, immunity, microbiological diagnostics of dysentery. Preparations for the etiotropic treatment.

*Yersinia*: general characteristics, sensitivity to environmental factors, main species. Etiology, pathogenesis, immunity, microbiological diagnostics of intestinal yersiniosis.

*Klebsiella*: general characteristics, main species. Pathogens of ozena and scleroma, characteristics. prevalence, pathogenesis, immunity, microbiological diagnostics of ozena and scleroma. Opportunistic *Klebsiella* (*K. pneumoniae*, *K. oxytoca* complex) and their role in human pathology. *Klebsiella* hospital ecovars, antibiotic resistance, production of extended spectrum beta-lactamase and carbapenemase. Hypervirulent (hypermuroid) *K.pneumoniae* strains and their role in infectious pathology. Microbiological diagnosis of Klebsiellosis.

*Proteus*: classification, distinctive features. Role in human pathology. Infection of the urinary system. The principle of microbiological diagnosis.

*Providencia*, *morganella*, *citrobacter*, *edwardsiella*, *enterobacter*, *hafnia*, *serrations*: general characteristics, role in human pathology.

***Vibrio***: systematic position, general characteristics, classification. *Vibrio cholerae*: history of the discovery, properties, sensitivity to environmental factors, antigenic structure (O1 and O139 serogroups, serovars), pathogenicity factors,

differences from non-cholera vibrio. Toxins and their mechanisms of action. Cholera: prevalence, pathogenesis, microbiological diagnostics. Drugs for chemo- and immunoprophylaxis of cholera. *Vibrio parahaemolyticus*, *Vibrio vulnificus*.

***Campylobacter*:** properties, culture requirements, species, sensitivity to environmental factors. Human campylobacteriosis, pathogenesis, immunity, microbiological diagnostics.

***Helicobacter*:** characteristics, pathogenicity factors, role in the development of peptic ulcer disease and gastric cancer. Microbiological diagnosis of helicobacteriosis, antimicrobial drugs for eradication therapy.

***Pseudomonas, Burkholder, acinetobakter, stenotrophomonas***

Non-fermenting gram-negative bacteria: general characteristics, features of biochemical activity and principles of microbiological diagnostics.

*Pseudomonas*: characteristics, classification, properties, existence in the hospital environment. *Pseudomonas aeruginosa*: pathogenicity factors, role in human pathology, sensitivity to antibiotics, antiseptics, disinfectants and environmental factors. Methods of microbiological diagnostics.

*Burkholderia*. Properties, role in human pathology.

*Acinetobacteria* - properties, role in human pathology. *Acinetobacter baumannii*: role in the etiology of healthcare-associated infections (HAI), features of antibiotic resistance.

*Stenotrophomonas* - properties, features of natural (species) antibiotic resistance, role in human pathology.

**3.4. Aerobic and facultative anaerobic gram-positive bacteria**

***Actinomycetes*:** systematic position, general characteristics, distribution. The role of actinomycetes in the cycle of substances. Production of antibiotics. Etiology, pathogenesis, microbiological diagnostics of actinomycosis.

***Mycobacteria*:** general characteristics, classification, acid resistance. Tuberculosis complex mycobacteria, species composition, morphology, culture requirements, growth rate on nutrient media, sensitivity to environmental factors and chemotherapeutic drugs, pathogenicity factors. Toxic lipids. Prevalence of tuberculosis, pathogenesis, immunity, allergy, anergy. Infection granuloma. Methods of microbiological diagnostics, immunoprophylaxis. Anti-tuberculosis drugs. Multiple and extensive drug resistance of mycobacteria. Principles of tuberculosis therapy.

Leprosy mycobacteria, characteristics. Prevalence, pathogenesis, immune status, microbiological diagnosis of leprosy.

Opportunistic human mycobacteria (nontuberculous mycobacteria). Mycobacterioses.

***Nocardia*:** systematic position, properties, role in human pathology.

***Corynebacterium*:** systematic position, general characteristics, classification. *Corynebacterium diphtheria*, properties, pathogenicity factors, toxigenicity, biovars, serovars, phage vars, sensitivity to environmental factors. Diphtheria: prevalence, pathogenesis, immunity, microbiological diagnostics, methods for determining the toxigenicity of isolated pure cultures. Diagnostics of a carrier state. Immunization,



monitoring of immune population. Preparations for immuno- and chemotherapy. Coryneform bacteria.

**Listeria:** systematic position, properties, role in human pathology. Pathogenesis, immunity, microbiological diagnostics and prevention of listeriosis.

Listeriosis of the fetus and newborn.

### 3.5. Ecological group of anaerobic bacteria

Phenomenon of anaerobiosis. Sensitive to oxygen and aerotolerant anaerobes. Sporogenous and asporogenous anaerobes. Gram-positive and Gram-negative anaerobes.

**Clostridia:** systematic position, general characteristics, classification, habitat, resistance to environmental factors, sporulation, pathogenicity factors. Principles and methods of microbiological diagnosis.

*Clostridium tetani*, properties. Tetanus exotoxin, structure, fractions, the mechanism of action. Pathogenesis of tetanus, immunity, passive and active immunoprophylaxis, immune population monitoring, immunotherapy.

Anaerobic gas infection clostridia, properties, toxins. Pathogenesis of gas gangrene, drugs for immunoprophylaxis and serotherapy.

*Clostridium botulinum*, properties. Pathogenesis of botulism, the connection with food intake. Botulinum toxin, serotypes, thermo-, acid- and enzyme resistance, signs of poisoning. Botulism serotherapy.

*Clostridium difficile*: morphological and biological features, pathogenicity factors, natural (specific) antibiotic resistance. *Clostridioides difficile*-associated infections, methods of diagnosis and therapy.

**Asporogenic gram-negative and gram-positive anaerobes.** Bacteroides, prevotella, porphyromonas, fusobacteria, peptococci, peptostreptococcus: characteristics, role in human pathology, principles of diagnosis.

### 3.6. Causative agents of especially dangerous and highly contagious infections

Classification of microbes and toxins of biological origin according to level. Anti-epidemic regimen for work with pathogens of IV-III risk groups. Especially dangerous infections, definition, features of microbiological diagnostics. The threat of bioterrorism. The main provisions of the International Health Regulations and the principles of sanitary protection of the Republic of Belarus from importation of infectious diseases.

**The causative agents of plague:** systematic position, general characteristics, antigenic structure, sensitivity to environmental factors, pathogenicity factors. Plague: natural foci, route of infection, pathogenesis, clinical forms, immunity, microbiological diagnostics. Preparations for the immunoprophylaxis of plague.

**The causative agent of tularemia:** systematic position, classification, general characteristics, antigenic structure, sensitivity to environmental factors, pathogenicity factors. Pathogenesis, immunity, microbiological diagnostics of tularemia. Live vaccine. Chemotherapy.

**Brucella:** systematic position, general characteristics, classification, sensitivity to environmental factors. Human brucellosis, prevalence, pathogenesis, immunity, methods of diagnostics. Preparations for immunization and chemotherapy.

**Bacilli:** systematic position, classification. *Bacillus anthracis*, properties, pathogenicity factors, sensitivity to environmental factors. Anthrax in humans, pathogenesis, prevalence, microbiological diagnostics. Ascoli's termoprecipitation test. Immunization (L. Pasteur), chemotherapy. Aerobic bacilli - agents of food poisoning.

### 3.7. Spirochetes

Systematic position, general characteristics, classification.

**Treponema:** general characteristics, classification. Treponema - agent of syphilis: morphology, tinctorial properties, antigenic structure, sensitivity to environmental factors, pathogenicity factors. Syphilis pathogenesis, microbiological diagnostics in different periods of the disease. Chemotherapy.

Congenital syphilis.

Endemic treponematoses.

**Leptospira:** properties, serogroups and serovars, sensitivity to environmental factors, pathogenicity factors. Leptospirosis, prevalence, pathogenesis, specific prophylaxis, microbiological diagnostics. Methods of culturing, growth characteristics. Agglutination-lysis reaction.

**Borrelia:** properties, antigenic structure. Etiology, pathogenesis, microbiological diagnostics of epidemic relapsing fever. Tick spirochetosis - endemic regions, pathogens. Etiology, pathogenesis, microbiological diagnostics, treatment and prevention of Lyme borreliosis.

### 3.8. Rickettsia, chlamydia, mycoplasma

**Rickettsia:** systematic position, general characteristics, morphological types, intracellular parasitism, sensitivity to environmental factors, pathogenicity factors. Classification of Rickettsia and rickettsiosis. Prevalence, etiology, pathogenesis, microbiological diagnostics, prevention of epidemic typhus. The pathogenesis of late recurrence of typhus. Prevalence, etiology, pathogenesis of endemic typhus.

*Orientia, Anaplasmas, Ehrlichia, Bartonella* - a role in human pathology.

**Chlamydia:** systematic position, general characteristics, classification. Species and serovars of Chlamydia. Morphology of elementary and reticular bodies. Chlamydia life cycle, intracellular inclusions. Etiology and pathogenesis of trachoma, immunity. Etiology and pathogenesis of lymphogranuloma venereum, urogenital and respiratory chlamydiosis. The causative agent of ornithosis and its role in human pathology. Microbiological diagnostics of chlamydial infections.

Prevention of trachoma and chlamydial conjunctivitis in newborns.

**Mycoplasma:** systematic position, classification, features of morphology and physiology, pathogenicity factors. The role of mycoplasma and ureaplasma in human infectious pathology. Pathogenesis and microbiological diagnosis of mycoplasmoses.

### 3.9. Fundamentals of medical mycology

Systematic position and classification of fungi. Human pathogenic fungi, morphology, biology, sensitivity to environmental factors, antigenic structure, pathogenicity factors. Features of mycotic infections. Immunity to fungal diseases. Principles of mycological diagnosis.



Etiology, pathogenesis, immunity, methods for diagnosis of cutaneous mycoses (epidermophytosis, trichophytosis, microsporia, favus). Causative agents of subcutaneous and deep (systemic) mycoses.

Mycoses caused by opportunistic fungi. Pathogenesis, immunity in diseases caused by *Candida*, *Aspergillus*, *Penicillium* and other fungi. Nosocomial mycoses. Diagnostics of candidomycosis.

*Pneumocystis*, general characteristics. Pneumocystis pneumonia as a complication of HIV infection. Cryptococci.

### **3.10. Basics of medical protozoology**

Systematic position, general characteristics and classification of protozoa. Pathogenic protozoa. Protozoan invasions, prevalence, classification, causes and conditions of development. Pathogenicity factors. Features of natural and acquired antiparasitic immunity. Protozoa antigens: characteristics, classification. Humoral and cellular immune response. Features of immuno-, chemoprophylaxis and chemotherapy for protozoan invasions. Methods of laboratory diagnostics of protozoan invasions.

Etiology and laboratory diagnosis of malaria.

Etiology and laboratory diagnosis of toxoplasmosis.

Etiology and laboratory diagnosis of amebiasis.

Etiology and laboratory diagnosis of balantidiasis.

Etiology and laboratory diagnosis of cryptosporidiosis.

Etiology, pathogenesis, immunity, laboratory diagnostics of urogenital trichomoniasis. Associative infections with chlamydia, mycoplasmas, gonococcus.

## **4. GENERAL AND SPECIAL MEDICAL VIROLOGY**

### **4.1. General virology**

History of viruses discovery (D.I. Ivanovsky, M.V. Beijerinck). Problems of medical virology, its relationship with other sciences, the value in the work of medical doctor. virological laboratory organization and objectives.

**Classification and morphology of viruses.** Viruses as an independent form of pathogens. The main features that distinguish viruses from other forms of organic matter. Classification of viruses. Morphology of naked (non-enveloped) and enveloped viruses. Features of the organization of vegetative and integral (provirus) viruses. Chemical composition of viruses. Viroids. Prions.

**The reproduction of viruses.** Strict parasitism and cytotropism of viruses: main factors. Stages of virus reproduction: adsorption, penetration, deproteinization, synthesis of early and late proteins, multiple genome replication, assembly of the virion, release of virions from the cell. Infectious, incomplete and defective viral particles. Productive, abortive and integrative cell infection. Virogeny.

**Genetics of viruses.** Genetic apparatus of viruses, D. Baltimore's classification. Mechanisms for the increase of the information density. Modifications in viruses: phenotypic mixing, complementation. Mutations in viruses. Genetic exchange in viruses. Recombination, genetic reactivation, hybridization. Genetic markers of virulence. Population variability in viruses, mechanisms, practical importance.

**Ecology of viruses.** Human and animal viruses. The sensitivity of viruses to physical and chemical environmental factors.

***Viruses of bacteria (bacteriophages).*** The morphology of the phage particle, chemical composition, properties. Virulent and temperate phages, characteristics of interaction with bacteria. Lysogenic infection. Phage conversion. Defective phages. Phage application for diagnostics, treatment and prevention of bacterial infections. Phage typing of bacteria. Sanitary-indicative value of bacteriophages.

***Viral diseases.*** Viruses as the etiology of cancer and infectious diseases. Prevalence, peculiarities of viral infections. The types of viral infections. Mechanisms of virus damage to host cells. Cytopathic and cytotoxic effects of viruses. Immune-mediated damage. Immunotropic, tolerogenic, tumorigenic, teratogenic viruses. The persistence of virus in the host. The pathogenesis of viral infections. Slow infection.

***Antiviral immunity.*** Factors of innate immunity. Cellular unresponsiveness. Antiviral inhibitors. Natural killer cells. Viral interference. Interferonogens. Interferons, types, properties, antiviral, antitumor, radioprotective, and immunomodulatory effect.

Acquired immunity to viral infections. Mechanisms of virions neutralization by antibodies. The cytotoxic effects of lymphocytes on virus infected cells. Mechanisms of immunodeficiency, allergic and autoimmune lesions development in viral infections.

Immunoprophylaxis and immunotherapy of viral infections.

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

***Virological diagnostic methods.*** Study of the morphology of viruses by electron and immunoelectron microscopy. Detection of viral inclusions and other tissue lesions. Cell culture. Methods for isolation, indication and identification of viruses in chicken embryo and cell cultures, laboratory animals. Serological diagnostics of viral infections. Neutralization of virus activity. Hemagglutination and hemadsorption inhibition tests. Rapid diagnostic methods: fluorescent antibodies test, ELISA, IHA. Methods of molecular genetic analysis: molecular hybridization, PCR, viral genome sequencing.

#### **4.2. RNA-genomic viruses**

***Orthomyxoviruses,*** characteristics and classification of the family. Influenza viruses: the structure of the virion, properties, antigenic structure and serotypes, antigenic variability and its consequences, the sensitivity to physical and chemical factors. Influenza, prevalence, pathogenesis, immunity, methods of virological diagnostics. Preparations for the specific therapy, immune- and chemoprophylaxis of influenza. Viruses of «bird» and «swine» flu. Influenza pandemics.

***Paramyxoviruses,*** characteristics and classification of the family. Parainfluenza viruses: structure, properties, serotypes. Pathogenesis, immunity, diagnostics of parainfluenza. Mumps virus: structure, properties. Pathogenesis, immunity, diagnostics, specific prevention of mumps.

***Morbillivirus.*** Measles virus: structure, properties. Measles, prevalence, pathogenesis, immunity, virological diagnostics. Preparations for active and passive immunization against measles. Mitigated measles, subacute sclerosing panencephalitis. Measles eradication program in the Republic of Belarus.



***Pneumoviruses:*** structure, properties, pathogenicity for humans.

***Coronaviruses:*** classification and role in human pathology, virion structure, properties. *SARS, MERS* viruses.

*SARS-Cov2* virus. COVID-19: pathogenesis, features of the immune status, virological diagnostics, specific prevention.

***Rubiviruses.*** Rubella virus, structure, biological properties, teratogenic effect. Rubella, pathogenesis, virological diagnosis, principles of prevention. Congenital rubella syndrome.

***Picornaviruses,*** characteristics and classification of the family.

***Enteroviruses:*** virion structure, properties of viruses, neurotropism, composition of the genus. Features of enteroviral infections. Etiology, pathogenesis, immunity, diagnosis and immunoprophylaxis of poliomyelitis (polio). Progress in the fight against polio. Coxsackie and ECHO viruses and their role in human pathology. Rhinoviruses: virion structure, serological types, biological properties. Prevalence, pathogenesis, immunity, diagnostics of acute infectious rhinitis.

***Astroviruses:*** virion structure, biological properties, role in human pathology.

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

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

***Retroviruses:*** characteristics and classification of the family. Human immunodeficiency viruses (HIV-1, HIV-2): history of discovery, virion morphology, virus genome, antigenic structure, sensitivity to physical and chemical factors. Genotypic, serological, phenotypic differences of HIV-1 subtypes. Characteristics of HIV reproduction in T-lymphocytes. HIV infection, prevalence, routes of infection, groups at high risk of infection. Formation of immunodeficiency and its characteristics. PreAIDS and its manifestations. AIDS-associated opportunistic infections and tumors. Diagnosis of HIV infection, etiotropic therapy. Highly active antiretroviral therapy (HAART). Primary and secondary prevention of AIDS and its complications. Features of HIV infection in HAART therapy.

***Rhabdoviruses:*** characteristics and composition of the family. Rabies virus: properties, resistance to physical and chemical factors. Routes for human infection, pathogenesis and virological diagnosis of rabies. Negri inclusions. The role of L. Pasteur in the development of a vaccine. Virus-fix. Modern rabies vaccine and gamma globulin for the prevention of rabies, indications for use.

#### 4.3. DNA-genomic viruses

***Poxviruses:*** characteristics and composition of the family. Variola virus. The history of immunization method development and global eradication (elimination) of the disease.

***Herpesviruses:*** characteristics and composition of the family, resistance to physical and chemical factors, biological properties, oncogenicity. Human herpes viruses (HHV):

*alpha herpesviruses.* Herpes simplex viruses 1 and 2 (HHV-1, HHV-2), properties. Pathogenesis of herpetic infections, immunity, virological diagnostics, chemotherapy and immunotherapy. *Varicella zoster virus* (VHV-3), properties.

Pathogenesis, immunity, diagnosis, prevention of chickenpox. Etiology and pathogenesis of herpes zoster;

*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, immunity, diagnosis of infectious mononucleosis. HHV-8, role in human pathology (Kaposi's sarcoma).

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

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

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

#### 4.4. Hepatitis viruses

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

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

Hepatitis B virus. Morphological and antigenic structure of the virion, oncogenicity. Routes of transmission, pathogenesis, immunity, virological diagnostics, 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. Drugs for the specific treatment of hepatitis C.

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

#### 4.5. Ecological group of arboviruses and reoviruses

General characteristics of arboviruses, the group composition, characteristics of associated diseases. Arbovirus and reovirus infections endemic to the Republic of Belarus.

**Togaviruses**, virion structure, biological properties, role in human pathology.

**Flaviviruses:** characteristics and classification of the family, natural focality of the diseases, transmission routes. Antigenic groups of flaviviruses. Tick-borne encephalitis, prevalence, characteristics of the pathogen, pathogenesis, immunity, virological diagnostics, immunoprophylaxis. Other diseases caused by flaviviruses (dengue fever, yellow fever, Japanese encephalitis, Zika fever).

**Bunyaviruses**, virion structure, biological properties. Distribution, agents, pathogenesis of Crimean hemorrhagic fever and hemorrhagic fever with renal syndrome. The causative agent of hantavirus fever.

**Arenaviruses**, virion structure, biological properties of viruses. The causative agent of Lassa fever.



***Filoviruses***: Ebola and Marburg viruses.

#### **4.6. Oncogenic viruses**

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

***Oncogenic DNA-genomic viruses*** - the mechanism of carcinogenesis.

***Oncogenic RNA genomic viruses***: systematic position, classification, structure and properties of viruses. Viral and cellular oncogenes. Mechanisms of malignant transformation of cells by RNA-genomic viruses. Signs of a tumor cell.

#### **5. CLINICAL MICROBIOLOGY**

Tasks, methods, objects of clinical microbiology. Opportunistic microbes, characteristics. Opportunistic infections: prevalence, conditions of development, risk factors, features of etiology and pathogenesis, principles and methods of microbiological diagnostics. Principles of the cultural method. Rules and methods for collecting and transporting material for cultural research. Criteria of the etiological significance of bacteria isolated from pathological focus. Features of sensitivity determination to antimicrobial drugs and antibiogram evaluation.

Etiology, pathogenesis, microbiological diagnostics of bacteremia, sepsis, septic shock, purulent-inflammatory diseases of the skin, subcutaneous tissue, internal organs, catheter-associated septic infections.

Etiology, pathogenesis, microbiological diagnosis of opportunistic bronchopulmonary diseases.

Etiology, pathogenesis, microbiological diagnosis of bacterial meningitis.

Etiology, pathogenesis, microbiological diagnosis of opportunistic uro- and urogenital infections (non-gonococcal urethritis, cystitis, pyelonephritis, bacterial vaginosis, etc.).

Etiology, pathogenesis, microbiological diagnosis of opportunistic intestinal infections.

Health Care-Associated Infections (HCAI): definition, reasons for wide distribution, socio-economic impacts, etiological structure. Hospital ecovars and strains of HCAI pathogens. Obligate pathogenic microorganisms - causative agents of HCAs. Exogenous and endogenous opportunistic pathogens - causative agents of HCAs. ESKAPE pathogens: Enterococci, Staphylococci, Klebsiella, Acinetobacter, Pseudomonas, Enterobacter. Development conditions, principles of microbiological diagnosis and prevention of HCAI. Microbiological monitoring of antibiotic resistance of HCAI pathogens. The concept of infection control in healthcare organizations.

### ACADEMIC DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	number of hours				Self-studies	Form of control
		lectures (including supervised independent work)	supervised student independent work	practicals			
<b>4 semester</b>							
<b>1</b>	<b>General microbiology</b>	<b>6</b>	<b>2</b>	<b>24</b>	<b>17</b>		
1.1	Microbiology as a science. World of microbes.	2	0,5	–	–	Interview	
1.3	Physiology of microorganisms	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.2	Morphology of microorganisms. Basic forms of bacteria. Bacterioscopic research method. Simple methods of staining	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.2	Bacterioscopic research method. The structure of the bacterial cell. Complex methods of staining.	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.2	Features of morphology and methods of studying spirochetes, rickettsia, chlamydia, mycoplasmas	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.5	Antimicrobial measures: methods of sterilization and disinfection, antiseptics, asepsis.	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.3	Cultural (bacteriological) research method. Methods for isolating pure cultures of bacteria	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.3	Cultural (bacteriological) research method. Methods for identification of pure cultures of bacteria	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.4	Genetics and Ecology of microorganisms	2	0,5	–	–	Interview	
1.5	Genetics of microorganisms. Methods for studying the genetics of bacteria. Methods of molecular diagnostics	–	–	3	2	Interview, control questioning, laboratory report, electronic tests	
1.6	Basics of the infection doctrine.	2	1	–	–	Interview	
1.7	Microbiological basics of chemotherapy and antiseptics of bacterial infections	–	–	3	3	Interview, control questioning, laboratory report, electronic tests	
1.5	Ecology of microorganisms. Methods of human normal flora	–	–	3	3	Interview, control questioning, laboratory report, electronic tests	



1.6	investigation. Basics of the infection doctrine. Biological research method					laboratory report, electronic tests
1.7	Microbiological basics of chemotherapy and antiseptics of bacterial infections. Methods for determining the sensitivity of microbes to antibiotics	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
	Concluding session «General microbiology»	–	–	3	2	Interview, control questioning, electronic tests
<b>2</b>	<b>Theoretical and applied medical immunology</b>	<b>8</b>	<b>2,5</b>	<b>24</b>	<b>19</b>	
2.1	Immunology. Immune system.	2	0,5	3	2	Interview, control questioning, laboratory report, electronic tests
2.2	Innate immunity	2	0,5	–	–	Interview
2.3	Immune response. Antigens. T- and B-lymphocytes. Antigen presenting cells. Humoral and cellular immune response. Antibodies	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.3	Methods of clinical and infectious immunology. Antigens. Humoral immune response. Antibodies	–	–	3	3	Interview, control questioning, laboratory report, electronic tests
2.3	Methods of clinical and infectious immunology. Cellular immune response.	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.4	Allergy and ecological immunology	–	–	–	–	Interview, control questioning, laboratory report, electronic tests
2.6	Immunodiagnosics of infectious diseases. Serological research method	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.6	Methods of clinical and infectious immunology. Solid phase immunological assay	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.5	Anti-infective immunity.	2	1	–	–	Interview
2.7	Immunoprophylaxis and immunotherapy of infectious diseases	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.5	Anti-infective immunity.	–	–	–	–	Interview
2.7	Immunoprophylaxis and immunotherapy of infectious diseases. Methods of vaccinal immunity evaluation	–	–	3	2	Interview, control questioning, laboratory report, electronic tests
2.4	Allergy and ecological immunology.	2	0,5	–	–	Interview
2.8	Basics of clinical immunology	–	–	3	3	Interview, control questioning, laboratory report, electronic tests
2.4	Allergy and ecological immunology.	–	–	–	–	Interview
2.8	Basics of clinical immunology. Methods of determination and estimation of the immune status. Immunopathology	–	–	3	3	Interview, control questioning, laboratory report, electronic tests
	Concluding session «Theoretical and applied medical immunology»	–	–	3	3	Interview, control questioning, electronic tests
<b>3</b>	<b>Special medical microbiology</b>	<b>4</b>	<b>1,5</b>	<b>3</b>	<b>3</b>	
3.1	Special medical microbiology. Gram-positive and gram-negative cocci:	2	0,5	–	–	Interview







3.10	Basics of Medical Protozoology							
3.9	Methods for microbiological diagnostics of mycoses and protozoal diseases	–	–	3	3		Interview, control questioning, laboratory report, electronic tests	
3.10		8	2,5	18	12			
<b>4</b>	<b>General and special medical virology</b>							
4.1	General medical virology. Viruses: taxonomy, morphology, reproduction, genetics. Viral infections. Antiviral immunity. Chemotherapy and chemoprophylaxis of viral infections	2	0,5	–	–		Interview	
4.1	Methods of viral infections diagnostics. Bacteriophages	–	–	3	2		Interview, control questioning, laboratory report, electronic tests	
4.2	RNA-genomic viruses. Orthomyxoviruses, Paramyxoviruses, Coronaviruses, Rubiviruses. Picornaviruses. Retroviruses	2	0,5				Interview	
4.2	Methods for virological diagnostics of diseases caused by Orthomyxoviruses, Paramyxoviruses, Coronaviruses, Rubiviruses	–	–	3	2		Interview, control questioning, laboratory report, electronic tests	
4.5	Arboviruses and viruses with natural foci. Rhabdoviruses. Oncogenic viruses	2	0,5	–	–			
4.2	Methods for virological diagnostics of diseases caused by Picornaviruses, Rotaviruses, Retroviruses	–	–	3	2		Interview, control questioning, laboratory report, electronic tests	
4.3	DNA-genomic viruses.	2	1	–	–		Interview	
4.4	Hepatitis viruses							
4.4	Methods for virological diagnostics of diseases caused by hepatitis viruses, herpes and adenoviruses	–	–	3	2		Interview, control questioning, laboratory report, electronic tests	
4.5								
4.3	Methods for virological diagnostics of diseases caused by arboviruses and viruses with natural foci. Oncogenic viruses	–	–	3	2		Interview, control questioning, laboratory report, electronic tests	
4.6	Concluding session «General and special medical virology»	–	–	3	2		Interview, control questioning, electronic tests	
<b>5</b>	<b>Clinical microbiology</b>	<b>2</b>	<b>1</b>	<b>6</b>	<b>6</b>			
5.0	Clinical microbiology	2	1	–	–		Interview	
	Clinical microbiology. Methods for microbiological diagnosis of purulent-septic infection of skin, subskin tissues, sepsis	–	–	3	3		Interview, control questioning, laboratory report, electronic tests	
	Methods for microbiological diagnosis of purulent-septic infection of respiratory tract and urogenital tract. Nosocomial infections	–	–	3	3		Interview, control questioning, laboratory report, electronic tests. Exam	
	<b>Total hours per semester:</b>	<b>18</b>	<b>6</b>	<b>54</b>	<b>48</b>			
	<b>Total hours:</b>	<b>36</b>	<b>12</b>	<b>105</b>	<b>87</b>			

## INFORMATION AND INSTRUCTIONAL UNIT LITERATURE

### Basic:

1. Генералов, И. И. Медицинская микробиология, вирусология и иммунология = Medical microbiology, virology and immunology : учеб. пособие для иностр. студентов учреждений высш. образования по спец. «Лечебное дело», «Стоматология», «Педиатрия». В 2 ч. Ч. 1 / Генералов, Игорь Иванович. - Витебск : ВГМУ, 2020. – 284 с.

2. Генералов, И. И. Медицинская микробиология, вирусология и иммунология = Medical microbiology, virology and immunology : учеб. пособие для иностр. студентов учреждений высш. образования по спец. «Лечебное дело», «Стоматология», «Педиатрия». В 2 ч. Ч. 2 / Генералов, Игорь Иванович. - Витебск : ВГМУ, 2020. – 402 с.

### Additional:

3. Generalov, I. I. Medical Microbiology, Virology & Immunology : Lecture Course for Students of Medical Universities. – Vitebsk : VSMU, 2016. P. I – 282 p.

4. Gillespie, S. H. Medical microbiology illustrated. – Butterworth-Heinemann, 2014. – 296 p.

5. Khaitov, R. M. Immunology : Textbook– М.: ГЭОТАР-Медиа, 2022. – 372 p.

6. Medical microbiology, virology, immunology : Textbook in 2 volumes. Vol. 1 / под ред. В. В. Зверева, М. Н. Бойченко. – М. : ГЭОТАР-Медиа, 2020. – 384 p.

7. Medical microbiology, virology, immunology : Textbook in 2 volumes. Vol. 2 / под ред. В. В. Зверева, М. Н. Бойченко. – М. : ГЭОТАР-Медиа, 2020. – 392 p.

8. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. Medical microbiology. – Elsevier Health Sciences, 2015. – 789 p.

9. McPherson, R. A., Pincus, M. R. Henry's clinical diagnosis and management by laboratory methods. – Elsevier Health Sciences, 2017. -1584 p.

10. Tortora, G. J. Microbiology: an introduction / G. J. Tortora, B. R. Funke, C. L. Case ; Pearson, 2019. – 960 p.

11. Punt, J. Kuby Immunology / J. Punt, S. Stranford, Jones P., Owen J. A. ; by W. H. Freeman and Company, 2019. – 944 p.

12. Черношей, Д. А. Лабораторный практикум по вирусологии = Laboratory workbook in virology : лабораторный практикум / Д. А. Черношей [и др.]. – 6-е изд. – Минск : БГМУ, 2021. – 24 с.

13. Черношей, Д. А. Иммунология = Immunology : лабораторный практикум / Д. А. Черношей, В. В. Слизень, Т. А. Канашкова. – 8-е изд. – Минск : БГМУ, 2021. – 64 с.

14. Слизень, В. В. Общая микробиология = General microbiology : лабораторный практикум / В. В. Слизень [и др.]. – 3-е изд. – Минск : БГМУ, 2021. – 79 с.



15. Черношей, Д. А. Частная и клиническая микробиология = Special and clinical microbiology : лабораторный практикум / Д. А. Черношей [и др.]. – 5-е изд. – Минск : БГМУ, 2021. – 55 с.

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

The hours allotted for self-study can be used for:

- preparation for lectures and laboratory classes;
- preparation for tests and exams in the academic discipline;
- solution of situational problems;
- performance of research and creative tasks;
- preparation of thematic reports, abstracts, presentations;
- performance of test tasks;
- taking notes of educational literature;
- review of scientific literature on a given topic;
- design of information and demonstration materials (stands, posters, graphics, tables, newspapers, etc.);
- making educational models, laboratory study guides, multimedia audio and video materials;
- reviewing a thematic selection of literary sources, Internet sources;
- preparation of tests for the organization of mutual assessment.

#### TOPICS FOR INDEPENDENT STUDY BY STUDENTS

##### **Etiology of slow infections. Prions and prion diseases**

**Prions:** history of discovery, properties. Pathogenesis, clinical manifestations and laboratory diagnostics of prion diseases (Creutzfeldt-Jakob disease, Gerstmann-Streussler-Scheinker syndrome, Kuru disease, fatal familial insomnia, transmissible spongiform cow's encephalopathy).

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

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

Main forms of supervised student independent work:

- writing and presentation of the abstract;
- presentation with a report;
- study of topics and problems that are not subject to lectures and laboratory classes;
- computer testing;
- preparation and participation in active forms of education.

Control of supervised independent student work is performed in the form of:  
 final class, colloquium in the form of an oral interview, written work, testing;  
 discussion of abstracts;  
 defending educational tasks, educational assignments;  
 assessment of an oral reply to a question, presentation, report or problem  
 solving in laboratory classes  
 checking up abstracts;  
 individual interview.

#### **LIST OF AVAILABLE DIAGNOSTIC TOOLS**

The following forms are used for competences assessment:

##### **Oral form:**

interviews;  
 control questioning;  
 credit;  
 exam.

##### **Written form:**

control questioning;  
 laboratory report.

##### **Oral-written form:**

reports on laboratory work with their oral defense.

##### **Technical form:**

electronic tests.

#### **LIST OF AVAILABLE TEACHING METHODS**

Linear (traditional) method (lecture, laboratory practicals);

Active (interactive) methods:

- Problem-Based Learning (PBL);
- Team-Based Learning (TBL);
- Research-Based Learning (RBL).

#### **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 a smear with an aqueous solution of fuchsin.
4. Staining a smear with an aqueous solution of methylene blue.
5. Microscopy of smears using an immersion system.
6. Staining of smears according to Gram.
7. Identification of staphylococci in the smear (Gram stain).
8. Identification of streptococci in the smear (Gram stain).
9. Identification of enterobacteria in the smear (Gram stain).
10. Identification of bacilli in the smear (Gram stain).
11. Identification of encapsulated bacteria in the smear (negative stain).
12. Identification of gonococcus in a pus smear (Gram stain).



13. Identification of mycobacteria in the sputum smear (Ziehl-Neelsen stain).
14. Identification of candida in the smear (Gram stain).
15. Identification of corynebacteria in the smear (Loeffler stain).
16. Inoculation of pathological material on meat-peptone agar (MPA) plate to isolate a pure culture of bacteria.
17. Determination of the colonies type on MPA plate.
18. Inoculation of slanted MPA from an isolated colony on MPA plate to accumulate pure culture.
19. Determination of the sensitivity/resistance of bacterial culture to antibiotics by disk diffusion method (algorithm and accounting).
20. Performance of slide agglutination test to identify unknown bacterium.
21. Indirect hemagglutination test results evaluation.
22. Tube agglutination test results evaluation to determine the antibody titer.
23. Evaluation of the results of the radial immunodiffusion by Mancini.
24. Evaluation of the results of the hemagglutination inhibition test for the identification of influenza viruses and serodiagnosis of viral infection.
25. Evaluation of the ELISA results.
26. Evaluation of PCR results.
27. Filling out primary medical documentation for laboratory diagnostics:
  - N 218 / y-07 «Microbiological study of biological material»;
  - N 351 / y-08 «Referral for clinical and microbiological research»;
  - N 354 / y-08 «Label for biomaterial samples».

### **LIST OF EQUIPMENT USED**

1. Light immersion microscope
2. Dark field microscope
3. Luminescent microscope
4. Thermostat
5. Plate spectrophotometer
6. Computers/tablets (computer class)
7. Multimedia projector
8. TV
9. Ovoscope
10. Alcohol burner
11. Bacteriological loops
12. Pipette dispensers
13. Laboratory glassware (Petri dishes, test tubes),
14. Nutrient media
15. Gram stain kit, reagents

### **LIST OF LECTURES**

#### **4th semester:**

1. Microbiology as a science. World of microbes. Physiology of microorganisms.

2. Genetics and ecology of microorganisms.
3. Basics of the infection doctrine. Microbiological bases of chemotherapy and antiseptics of bacterial infections.
4. Immunology. The immune system. Innate immunity.
5. Immune response of the body. Antigens. T- and B-lymphocytes. Antigen presenting cells. Humoral and cellular immune response. Antibodies.
6. Anti-infective immunity. Immunoprophylaxis and immunotherapy of infectious diseases.
7. Allergy and ecological immunology. Basics of clinical immunology.
8. Special medical microbiology. Gram-positive and gram-negative cocci: staphylococci, streptococci, neisseria.
9. Aerobic and facultative anaerobic gram-negative rod-shaped bacteria: enterobacteria, vibrios, campylobacter, helicobacter.

**5th semester:**

1. Corynebacteria. Bordetella and hemoglobinophilic bacteria. Legionella.
2. Actinomycetes. Mycobacteria. Listeria. Ecological group of obligate anaerobes.
3. Spirochetes, rickettsia, chlamydia, mycoplasmas.
4. Basics of medical mycology and protozoology.
5. General medical virology. Viruses: morphology, reproduction, genetics. Viral diseases. Antiviral immunity. Chemotherapy and chemoprophylaxis of viral infections.
6. RNA-genomic viruses. Orthomyxoviruses, Paramyxoviruses, Coronaviruses, Rubiviruses. Picornaviruses. Retroviruses.
7. Arboviruses and viruses with natural foci. Rhabdoviruses. Oncogenic viruses.
8. DNA-genomic viruses. Hepatitis viruses.
9. Clinical microbiology.

### LIST OF LABORATORY STUDIES

**4th semester:**

1. Morphology of microorganisms. Basic forms of bacteria. Bacterioscopic research method. Simple methods of staining.
2. Bacterioscopic research method. The structure of the bacterial cell. Complex methods of staining. Features of morphology and methods of studying spirochetes, rickettsia, chlamydia, mycoplasmas.
3. Antimicrobial measures: methods of sterilization and disinfection, antiseptics, asepsis. Cultural (bacteriological) research method. Methods for isolating pure cultures of bacteria.
4. Cultural (bacteriological) research method. Methods for identification of pure cultures of bacteria.
5. Genetics of microorganisms. Methods for studying the genetics of bacteria. Methods of molecular diagnostics.
6. Ecology of microorganisms. Methods of human normal flora investigation. Basics of the infection doctrine. Biological research method.



7. Microbiological bases of chemotherapy and antiseptics of bacterial infections. Methods for determining the sensitivity of microbes to antibiotics.
8. Concluding session «General microbiology».
9. Immunology. The immune system. Innate immunity.
10. Methods of clinical and infectious immunology. Antigens. Humoral immune response. Antibodies.
11. Methods of clinical and infectious immunology. Cellular immune response. Allergy and ecological immunology.
12. Immunodiagnosics of infectious diseases. Serological research method.
13. Methods of clinical and infectious immunology. Solid phase immunological assay.
14. Anti-infective immunity. Immunoprophylaxis and immunotherapy of infectious diseases. Methods of vaccinal immunity evaluation.
15. Allergy and ecological immunology. Basics of clinical immunology. Methods of determination and estimation of the immune status. Immunopathology
16. Concluding session: «Theoretical and applied medical immunology.»
17. Special medical microbiology. Methods for microbiological diagnostics of diseases caused by staphylococci, streptococci, neisseria. Credit.

#### **5th semester:**

1. Methods for microbiological diagnostics of acute intestinal infections caused by enterobacteria.
2. Methods for microbiological diagnostics of diseases caused by Klebsiella, Yersinia, Campylobacter, Pseudomonas. Principles of food poisoning diagnosis.
3. Methods for microbiological diagnostics of diseases caused by corynebacteria, bordetella, hemoglobinophilic bacteria, legionella.
4. Methods for microbiological diagnostics of diseases caused by actinomycetes, mycobacteria, listeria.
5. Methods for microbiological diagnostics of anaerobic infections.
6. Methods for microbiological diagnostics of especially dangerous infections: cholera, plague, tularemia, brucellosis, anthrax.
7. Methods for microbiological diagnostics of diseases caused by spirochetes.
8. Methods for microbiological diagnostics of diseases caused by rickettsia, chlamydia, mycoplasmas.
9. Concluding session «Special bacteriology».
10. Methods for microbiological diagnostics of mycoses and protozoal diseases.
11. Methods of virological research. Bacteriophages.
12. Methods for virological diagnosis of diseases caused by orthomyxoviruses, paramyxoviruses, coronaviruses, rubiviruses.
13. Methods for virological diagnosis of diseases caused by picornaviruses, rotaviruses, retroviruses.
14. Methods for virological diagnosis of diseases caused by hepatitis viruses, herpesviruses, adenoviruses.

15. Methods for virological diagnosis of diseases caused by arboviruses and viruses with natural foci. Oncogenic viruses.
16. Concluding session «General and special medical virology».
17. Clinical microbiology. Methods for diagnosis of purulent-septic infections of the skin, subcutaneous tissue, sepsis.
18. Microbiological diagnosis of purulent-septic infections of the respiratory tract and urogenital tract. Nosocomial infections.




**PROTOCOL OF THE CURRICULUM APPROVAL  
BY OTHER DEPARTMENTS**

Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol T)
1. Epidemiology	Epidemiology	No proposals	29.09.2022, protocol № 4
2. Dermatovenereology	Skin and venereal diseases	No proposals	29.09.2022, protocol № 4
3. Phthisiopulmonology	Phthisiopulmonology	No proposals	29.09.2022, protocol № 4
4. Internal Diseases	1-st Internal Diseases 2nd Internal Diseases	No proposals	29.09.2022, protocol № 4
5. Clinical Immunology, Allergology	2nd Internal Diseases	No proposals	29.09.2022, protocol № 4
6. Infectious Diseases	Infectious Diseases	No proposals	29.09.2022, protocol № 4
7. Pediatric Infectious Diseases	Pediatric Infectious Diseases	No proposals	29.09.2022, protocol № 4

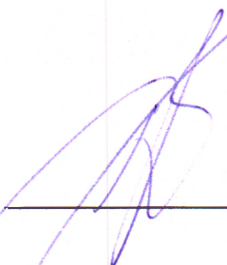
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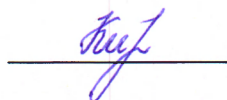
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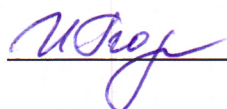
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I.A.Gavrilova

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

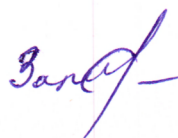
Dean of the Medical Faculty for International Students of the educational institution «Belarusian State Medical University»

15.11.2022



O.S.Ishutin





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S.V.Zaturanova



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