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

APPROVED
by Rector of the Educational Institution «Belarusian State Medical University»
_____ S.P.Rubnikovich
20.11.2024
Reg. # UD-091-092/2425/edu.

MICROBIOLOGY, VIROLOGY, IMMUNOLOGY

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

7-07-0911-01 «General Medicine»

2024

Curriculum is based on the educational program «Microbiology, Virology, Immunology», approved 20.11.2024, registration # УД-091-092/2425/уч.; on the educational plan in the specialty 1-79 01 01 «General Medicine», approved 15.05.2024, registration # 7-07-0911-01/2425/mf.

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RECOMMENDED FOR APPROVAL:

by the Department of Microbiology, Virology, Immunology of the Educational Institution «Belarusian State Medical University»
(protocol # 2 of 18.09.2024);

by the Scientific and Methodological Council of the Educational Institution «Belarusian State Medical University»
(protocol # 3 of 20.11.2024)

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 of basic professional competency for diagnostics, prevention, etiotropic therapy of human infectious and parasitic diseases; assessment and correction of the human immune system.

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;

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;

microbial sensitivity and resistance to environmental factors and methods of sterilization, disinfection, asepsis, antisepsis, necessary for medical specialist;

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», «Clinical Immunology, Allergology», «Infectious Diseases», «Pediatric Infectious Diseases».

Studying the educational discipline «Microbiology, Virology, Immunology» should ensure the formation of students' basic professional competency: 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 etiotropic treatment and immunoprevention of infections and protozoan invasions;

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;

rules of medical ethics and deontology;

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 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, of which 141 classroom hours and 87 hours of student independent work. Classroom hours according to the types of studies: lectures – 36 hours (including 9 hours of supervised student independent work (SSIW)), laboratory classes – 105 hours).

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

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	Including			out-of-class self-studies	
				lectures	supervised student independent work	laboratory practicals		
7-07-0911-01 «General Medicine»	4	108	72	15	6	51	36	credit
	5	120	69	12	3	54	51	examination
		228	**141**	**27**	**9**	**105**	**87**	

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	laboratory
1. General microbiology	**6**	**24**
1.1. Microbiology as a science. The world of microbes	1,5	–
1.2. Morphology of microorganisms	–	6
1.3. Physiology of microorganisms	1,5	6
1.4. Genetics of microorganisms		3
1.5. Ecology of microorganisms	1,5	3
1.6. Fundamentals of infectology		3
1.7. Microbiological basics of chemotherapy and antiseptics of bacterial infections	1,5	3
2. Theoretical and applied medical immunology	**10,5**	**24**
2.1. Immunology as a science. Immune system	1,5	–
2.2. Innate immunity		3
2.3. Immune response	1,5	3
2.4. Allergy and ecological immunology	1,5	3
2.5. Anti-infection immunity	1,5	3
2.6. Immunodiagnostics of infectious diseases	–	6
2.7. Immunoprophylaxis and immunotherapy of infectious diseases	1,5	3
2.8. Basics of clinical immunology	3	3
3. Special medical microbiology	**10,5**	**33**
3.1. Gram-positive cocci	1,5	3
3.2. Neisseria	1,5	
3.3. Aerobic and facultative anaerobic gram- negative rods	1,5	9
3.4. Aerobic and facultative anaerobic gram-positive bacteria	1,5	3
3.5. Ecological group of anaerobic bacteria	1,5	3
3.6. Causative agents of especially dangerous and highly contagious infections	–	3
3.7. Spirochetes	1,5	3
3.8. Ricketsia, chlamidia, mycoplasm	–	6
3.9. Fundamentals of medical mycology	1,5	–
3.10. Basics of medical protozoology	–	3
4. General and special medical virology	**7,5**	**18**
4.1. General virology	1,5	3
4.2. RNA-genomic viruses	1,5	6
4.3. DNA-genomic viruses	1,5	1,5
4.4. Hepatitis viruses	1,5	1,5
4.5. Ecological group of arboviruses and roboviruses	1,5	3
4.6. Oncogenic viruses	–	1,5
4.7. Etiology of slow infections. Prions and prion diseases	–	1,5
5. Clinical microbiology	**1,5**	**6**
Total hours	**36**	**105**

CONTENT OF THE EDUCATIONAL DISCIPLINE

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 humanitarian 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. Average nucleotide identity (ANI) index. The mixed approach to systematization.

Taxonomic categories: the domain, type, 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. Classification of bacteria according to Bergey's manual.

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. Features of the chemical composition of bacteria compared to eukaryotic organisms. The structure of a bacterial cell. Nucleoid. Plasmids. Ribosomes. Inclusions. A cytoplasmatic membrane, mesosomes. Periplasmatic 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).

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

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.

Preparation of fixed smears from agar and broth cultures of bacteria, staining with aqueous solutions of fuchsin, methylene blue and by Gram method; microscopy of preparations using an immersion system; detection and determination of the morphology of staphylococci, streptococci, enterobacteria, vibrio, bacilli in smears stained by Gram method.

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.

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.

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. Dynamics (phases) of development of a bacterial population in a periodic culture.

Objectives, 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.

Inoculation of a solid nutrient medium in Petri dish to get isolated colonies; determination of the colony morphotype; preparation of fixed preparations from an agar culture of bacteria with Gram staining; plating an isolated colony onto a slanted meat-peptone agar to accumulate a pure bacterial culture.

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 reverse 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.

Registration of PCR results (detection of amplification products, interpretation of results).

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

Ecological microbiology emerging 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 anthropogenies 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.

Ecological factors influence on microorganisms. 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. Sterilization and disinfection quality control. 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 (Varron, 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 20th and early 21st 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 routs 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 of drugs.

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 (Jarisch-Herxheimer reaction), secondary infection, the negative organotropic effect (toxic, allergenic, teratogenic, mutagenic, carcinogenic).

The main groups of antimicrobial drugs: sulfonamides, azoles, quinolines, 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.

Indications 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).

Determination of sensitivity/resistance of bacterial culture to antibiotics using the disk diffusion method (performance, recording, interpretation of results).

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. Organs of the immune system (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 innate immunity: barrier and antimicrobial properties of the skin, mucous membranes, lymph nodes, tissue unresponsiveness, normal microflora. Protective function of the respiratory,

digestive, endocrine and other systems of the human body. 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. Control mechanisms for complement system activation. Methods for the complement system activity assaying. Lysozyme. Acute-phase proteins. Natural antibodies.

Polymorphonuclear and mononuclear phagocytes (origin, characteristics, functions). Phagocytic reaction (phases, 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 (classical and alternative) and the regulation of their functions. Neutrophil extracellular traps.

Natural killer cells, the mechanism of damage to the target cells. γδ-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, typal 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. Memory B-cells. Methods for assaying 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 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 (fetus), 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. Immediate type hypersensitivity (ITH). ITH 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 ITH type I.

Ecological immunology: definition, objects of study. Immunotropic ecological 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 in 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.

Performance and recording the slide agglutination tests for identification of bacteria; recording the tube agglutination test and indirect (passive) hemagglutination for determination of antibody titer.

Solid-phase immunoassay: fluorescent antibodies test, immunoelectron microscopy (IEM), enzyme-linked immunosorbent assay (ELISA), immunochromatography assay (ICA) - the principles, variants of performance, results accounting, evaluation, application. Immunoblotting (Western blotting). Express tests.

Registration of results of the enzyme immunoassay (filling out research protocol, assessing the reliability of the experiment and interpreting the results).

2.7. Immunoprophylaxis and immunotherapy of infectious diseases

Immunoprophylaxis **:** definition. Active immunoprophylaxis. National immunization schedule and the list of preventive vaccinations for epidemiological indications. Vaccine, requirements: immunogenicity, safety, areactogenicity, stability, associability. 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 and mRNA 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.

Transplant immunity. Types of transplants. Transplant antigens. Conditions for 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, indications. The use of the immunotropic drugs 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 (local, systemic, generalized). Staphylococcal food intoxication, pathogenesis, immunity and methods for microbiological diagnostics. Toxic shock syndrome. «Scalded skin» syndrome. Hospital ecovars of staphylococci: phage-, resistance- and genotyping. Methicillin and vancomycin resistant *Staphylococcus aureus* (MRSA, VRSA); *S.aureus* intermediate resistant to vancomycin (VISA). Drugs for etiotropic therapy of staphylococcal infections, antiseptics.

Preparation of fixed smears from agar culture of *S.aureus*, staining by Gram method; detection and determination of staphylococci morphology in smears stained by Gram method.

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, toxic shock syndrome toxin). Etiology, pathogenesis, immunity, diagnostics, prevention of acute and chronic streptococcal infections and poststreptococcal diseases (purulent-septic infections, streptodermia, chronic tonsillitis, scarlet fever, erysipelas, rheumatic fever, glomerulonephritis). 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.

Preparation of fixed smears from a broth culture of streptococci, staining by Gram method; determination of the morphology of streptococci in smears stained by Gram method.

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 gonoblennorrhea. Gonoblennorrhea prevention in newborns.

Detection and determination of morphology of gonococcus in a smear of pus.

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.

3.3. Aerobic and facultative anaerobic gram-negative rods

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. 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 shigellosis (bacterial 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. Opportunistic klebsiella (*K. pneumoniae, K. oxytoca*) and their role in human pathology. Klebsiella hospital ecovars, antibiotic resistance, production of extended spectrum beta-lactamase and carbapenemase. Hypervirulent (hypermucoid) *K. pneumoniae* strains and their role in infectious pathology. Microbiological diagnosis of Klebsiellosis. Pathogens of ozena and scleroma.

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

Providence, morganella, citrobacter, edwardsiella, enterobacter, hafnia, serratia: general characteristics, role in human pathology.

Preparation of fixed smears from agar culture of enterobacteria, staining by Gram method; microscopy of preparations using an immersion system; detection and determination of enterobacteria morphology in smears stained by Gram; detection and determination of the morphology of Klebsiella in smears stained by Burry-Gins; performance and recording the slide agglutination test to identify bacteria; recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria; recording the tube agglutination tests and indirect (passive) hemagglutination to determine the antibody titer.

Vibrio: systematic position, general characteristics, classification. *Vibrio cholerae*: history of the discovery, properties, sensitivity to environmental factors, antigenic structure (O1 and 0139 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.*

Detection and determination of vibrio morphology in Gram-stained smears.

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.

Microscopic examination of Ziehl-Neelsen stained sputum smears to detect mycobacteria.

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.

Preparation of fixed smears from agar culture of bacteria, staining with methylene blue; detection and determination of the morphology of corynebacteria in smears stained by Loeffler; registration of the indirect (passive) hemagglutination reaction to determine the antibody titer.

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 (species) 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 of non-clostridial anaerobic infections.

3.6. Causative agents of especially dangerous and highly contagious infections

Classification of microbes and toxins of biological origin according to biohazard 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 the 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 immunophylaxis 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. *Bacillus cereus*, general characteristics, role in human pathology.

Detection and determination of bacilli morphology in Gram-stained smears. Detection and determination of brucella morphology in Gram-stained smears.

3.7. Spirochetes

Systematic position, general characteristics, classification.

Treponema: general characteristics, classification. *Treponema pallidum*: 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.

Detection and determination of Candida morphology in Gram-stained smears.

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.Beijerink). 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, 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, variants. 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, 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 infections. 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 cytolytic effects of viruses. Immune-mediated damage of infected cells. Immunotropic, tolerogenic, tumorigenic, teratogenic effect of 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, classes, properties, antiviral, antitumor and immunomodulatory effects.

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 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 by cytoscopy. Cell culture. Methods for isolation, indication and identification of viruses in chicken embryo, cell cultures, laboratory animals. Serological diagnostics of viral infections. Neutralization test. Hemagglutination and hemadsorption inhibition tests. Rapid diagnostic methods: fluorescent antibodies test, ELISA, IHA. Methods of molecular genetic analysis: molecular hybridization, PCR, viral genome sequencing.

Registration the hemagglutination inhibition test for seroidentification of the influenza virus and serodiagnostics of viral infection.

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.

Registration of the hemagglutination inhibition test for seroidentification of the influenza virus and serodiagnostics of viral infection.

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. RSV infection: pathogenetic features of the disease, virological diagnostics, immunity, prevention.

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, immunoprevention.

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. Routs 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, peculiarities of reproduction and persistence, 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* (HHV-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, 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. Routs 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.

Registration of the results of the enzyme immunoassay (filling out the research protocol, assessing the reliability of the experiment and interpreting the results).

4.5. Ecological group of arboviruses and roboviruses

General characteristics of arboviruses, the group composition, characteristics of associated diseases. Arbovirus and robovirus 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-Congo 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 cell transformation by RNA-genomic viruses. Features of a transformed cell.

4.7. 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-Sträussler-Scheinker syndrome, Kuru disease, fatal familial insomnia, transmissible spongiform encephalopathy of cows).

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

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 application for opportunistic infections diagnostics. Rules and methods for samples collection and transport for cultural research. Criteria of the etiological significance of opportunistic bacteria isolated. Features of sensitivity to antimicrobial drugs determination and interpretation.

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.

Preparation of fixed smears from agar and broth cultures of bacteria, staining by Gram method; microscopy of preparations using an immersion system; detection and determination of the morphology of staphylococci and enterobacteria in smears stained by Gram method; plating an isolated colony onto a slanted meat-peptone agar to accumulate a pure culture of bacteria; recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria; determination of the sensitivity/resistance of a bacterial culture to antibiotics using the disk diffusion method (performance, recording, interpretation of results).

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 HCAIs. Exogenous and endogenous opportunistic pathogens - causative agents of HCAIs. 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.

EDUCATIONAL DISCIPLINE «MICROBIOLOGY, VIROLOGY, IMMUNOLOGY» CURRICULAR CHART

Section, topic #	Section (topic) name	Number of class hours		Supervised student independent work	Literature	Practical skill	Form of control	
		lecture	laboratory				of practical skills	of current / intermediate assessment
4 semester								
	Lectures	**15**	–	**6**				
1.	Microbiology as a science. World of microbes	1,5	–	–	1, 5, 7, 8, 12			
2.	Physiology of microorganisms. Genetics of microorganisms	1,5	–	–	1, 5, 7, 8, 12			
3.	Basics of the infection doctrine. Ecology of microorganisms	–	–	1,5	1, 5, 7, 8, 12			Abstract defending, electronic tests
4.	Microbiological basics of chemotherapy and antiseptics of bacterial infections	1,5	–	–	1, 5, 7, 8, 12			
5.	Immunology. Immune system. Innate immunity	1,5	–	–	1, 5, 7, 8, 12			
6.	Immune response. Antigens. Antigen presenting cells. T- and B-lymphocytes. Humoral and cellular immune response. Antibodies. Immunological tolerance	1,5	–	–	1, 5, 7, 8, 12			
7.	Allergy and ecological immunology	1,5	–	–	1, 5, 7, 8, 12			
8.	Anti-infective immunity	–	–	1,5	1, 5, 7, 8, 12			Abstract defending, electronic tests

9.	Immunoprophylaxis and immunotherapy of infectious diseases	1,5	–	–	1, 5, 7, 8, 12			
10.	Basics of clinical immunology. Immune status. Immunodeficiencies	1,5	–	–	1, 5, 7, 8, 12			
11.	Autoimmune diseases	–	–	1,5	1, 5, 7, 8, 12			Abstract defending, electronic tests
12.	Special medical microbiology. Gram-positive and gram-negative cocci: Staphylococci, Streptococci	1,5	–	–	2, 6, 7, 9, 12			
13.	Neisseria, hemoglobinophilic bacteria. Bordetella	–	–	1,5	2, 6, 7, 9, 12			Abstract defending, electronic tests
14.	Aerobic and facultative anaerobic gram-negative rod-shaped bacteria: Enterobacteria, Vibrio, Campylobacter, Helicobacter	1,5	–	–	2, 6, 7, 9, 12			
	Laboratory classes	–	**51**	–				
1.	Morphology of microorganisms. Basic forms of bacteria. Bacterioscopic research method. Simple methods of staining	–	3	–	1, 3, 4, 5, 7, 8, 10, 11, 12	1. Compliance with aseptic rules when working with microorganisms of the 1st biological risk group. 2. Preparation of a fixed smear from an agar culture of bacteria. 3. Preparation of a fixed smear from a broth culture of bacteria. 4. Staining a fixed smear with an aqueous solution of fuchsin. 5. Staining a fixed smear with an aqueous solution of methylene blue. 6. Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
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	–	1, 3, 4, 5, 7, 8, 10, 11, 12	1. Preparation of a fixed smear from an agar culture of bacteria. 2. Staining a fixed smear by Gram method. 3. Microscopy of smears using an immersion system.	Laboratory report	Interview, electronic tests

						4. Detection and determination of morphology of staphylococci in smears stained by Gram. 5. Detection and determination of the morphology of enterobacteria in smears stained by Gram. 6. Detection and determination of the morphology of Klebsiella in smears stained by Burri-Gins. 7. Microscopic examination of sputum smears stained by Ziehl-Neelsen to detect mycobacteria. 8. Detection and determination of the morphology of corynebacteria in smears stained by Loeffler		
3.	Genetics of microorganisms. Methods for studying the genetics of bacteria. Methods of molecular diagnostics	–	3	–	1, 3, 5, 7, 8, 10, 11, 12	Registration of the results of the polymerase chain reaction (detection of amplification products, interpretation of results)	Laboratory report	Interview, electronic tests
4.	Antimicrobial measures: methods of sterilization and disinfection, antiseptics, asepsis. Cultural (bacteriological) research method. Methods for isolating pure cultures of bacteria	–	3	–	1, 3, 5, 7, 8, 10, 11, 12	1. Compliance with aseptic rules when working with microorganisms of biological risk group 1. 2. Determination of the morphotype of colonies on a solid nutrient medium in a Petri dish. 3. Plating an isolated colony on a slanted meat-peptone agar to accumulate a pure culture of bacteria	Laboratory report	Interview, electronic tests
5.	Cultural (bacteriological) research method. Methods for identification of pure cultures of bacteria	–	3	–	1, 3, 5, 7, 8, 10, 11, 12	1. Preparation of a fixed smear from an agar culture of bacteria. 2. Staining of a fixed smear by Gram method. 3. Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
6.	Basics of the infection doctrine. Methods of human normal flora	–	3	–	1, 3, 5, 7, 8, 10,	1. Preparation of a fixed smear from an agar culture of bacteria.	Laboratory report	Interview, electronic tests

	investigation				12	2. Staining of a fixed smear by Gram method. 3. Microscopy of smears using an immersion system		
7.	Microbiological basics of chemotherapy and antiseptics of bacterial infections. Methods for determining the sensitivity of microbes to antibiotics. Biological research method	–	3	–	1, 3, 5, 7, 8, 10, 12	Determination of sensitivity/resistance of bacterial culture to antibiotics using the disk diffusion method (algorithm for performance, recording, interpretation of results)	Laboratory report	Interview, electronic tests
8.	Ecology of microorganisms. Concluding session «General microbiology»	–	3	–	1, 3, 4, 5, 7, 8, 10, 11, 12	1. Compliance with aseptic rules when working with microorganisms of biological risk group 1. 2. Preparation of a fixed smear from an agar culture of bacteria. 3. Preparation of a fixed smear from a broth culture of bacteria. 4. Staining a fixed smear by Gram method. 5. Microscopy of smears using an immersion system. 6. Detection and determination of the morphology of staphylococci in smears stained by Gram. 7. Detection and determination of the morphology of streptococci in smears stained by Gram. 8. Detection and determination of the morphology of enterobacteria in smears stained by Gram. 9. Detection and determination of the morphology of bacilli in smears stained by Gram. 10. Detection and determination of Klebsiella morphology in smears stained by Burri-Gins.	Laboratory report *	Electronic tests, colloquium*

						11. Determination of sensitivity/resistance of bacterial culture to antibiotics using the disk diffusion method (algorithm for performance, recording, interpretation of results). 12. Plating an isolated colony on slanted meat-peptone agar to accumulate a pure culture of bacteria		
9.	Immune system. Innate immunity	–	3	–	1, 3, 5, 7, 8, 12	Detection and determination of gonococcal morphology in Gram-stained pus smears	Laboratory report	Interview, electronic tests
10.	Antigens. Humoral immune response. Antibodies	–	3	–	1, 3, 5, 7, 8, 12	Recording the Mancini radial immunodiffusion reaction to determine the concentration of immunoglobulin G	Laboratory report	Interview, electronic tests
11.	Cellular immune response. Allergy and ecological immunology	–	3	–	1, 3, 5, 7, 8, 12	Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
12.	Immunodiagnostics of infectious diseases. Serological research method	–	3	–	1, 3, 5, 7, 8, 12	1. Performance and recording the slide agglutination test. 2. Recording the indirect (passive) hemagglutination test. 3. Recording the tube agglutination test to determine the antibody titer	Laboratory report	Interview, electronic tests
13.	Methods of clinical and infectious immunology. Solid phase immunological assay	–	3	–	1, 3, 5, 7, 8, 11, 12	Recording the results of the enzyme immunoassay (filling out the research protocol, assessing the reliability of the experiment and interpreting the results)	Laboratory report	Interview, electronic tests
14.	Immunoprophylaxis and immunotherapy of infectious diseases. Methods of vaccinal immunity evaluation	–	3	–	1, 3, 5, 7, 8, 12	1.Recording the indirect (passive) hemagglutination test. 2.Recording the tube agglutination test to determine the antibody titer	Laboratory report	Interview, electronic tests
15.	Basics of clinical immunology. Methods of determination and estimation of the immune status.	–	3	–	1, 3, 5, 7, 8, 12	Recording the indirect (passive) hemagglutination test	Laboratory report	Interview, electronic tests

	Immunopathology. Transplant immunity. Anti-tumor immunity							
16.	Anti-infective immunity. Concluding session «Theoretical and applied medical immunology»	–	3	–	1, 3, 5, 7, 8, 11, 12	1. Recording the indirect (passive) hemagglutination test. 2. Performance and recording the slide agglutination test	Laboratory report *	Electronic tests, colloquium*
17.	Special medical microbiology. Methods for microbiological diagnostics of diseases caused by Staphylococci, Streptococci, Neisseria	–	3	–	2, 3, 6, 7, 9, 12	1. Detection and determination of morphology of staphylococci in smears stained by Gram. 2. Detection and determination of morphology of streptococci in smears stained by Gram. 3. Detection and determination of morphology of gonococci in pus smears stained by Gram	Laboratory report	Interview, electronic tests Credit
	5th semester							
	Lectures	**12**	–	**3**				
1.	Corynebacteria. Bordetella and hemoglobinophilic bacteria. Legionella	1,5	–	–	2, 6, 7, 9, 12			
2.	Actinomycetes. Mycobacteria. Listeria. Ecological group of obligate anaerobes	1,5	–	–	2, 6, 7, 9, 12			
3.	Spirochetes. Rickettsia, Chlamydia, Mycoplasma	1,5	–	–	2, 6, 7, 9, 12			
4.	General medical virology. Viruses: morphology, reproduction, genetics. Viral infections. Antiviral immunity. Chemotherapy and chemoprophylaxis of viral infections	1,5	–	–	2, 6, 7, 9, 12			
5.	RNA-genomic viruses. Orthomyxoviruses, Paramyxoviruses, Coronaviruses, Rubiviruses. Picornaviruses	1,5	–	–	2, 6, 7, 9, 12			
6.	Arboviruses and viruses with natural foci. Rhabdoviruses	1,5	–	–	2, 6, 7, 9, 12			

7.	Hepatitis viruses. Retroviruses	1,5	–	–	2, 6, 7, 9, 12			
8.	DNA-genomic viruses. Oncogenic viruses	–	–	1,5	2, 6, 7, 9, 12			Abstract defending, electronic tests
9.	Clinical microbiology	1,5	–	–	2, 6, 7, 9, 12			
10.	Basics of medical mycology and protozoology	–	–	1,5	2, 6, 7, 9, 12			Abstract defending, electronic tests
	Laboratory classes		**54**					
1.	Methods for microbiological diagnostics of acute intestinal infections caused by Enterobacteria Diagnostics of escherichiosis, typhoid fever, paratyphoid fever, salmonellosis	–	3	–	2, 3, 6, 7, 9, 12	1. Determination of the morphotype of colonies on a solid nutrient medium in a Petri dish. 2. Preparation of a fixed smear from an agar culture of bacteria. 3. Staining a fixed smear by Gram method. 4. Microscopy of smears using an immersion system. 5. Recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria. 6. Performance and recording a slide agglutination test. 7. Plating an isolated colony onto a slanted meat-peptone agar to accumulate a pure culture of bacteria. 8. Detection and determination of the morphology of enterobacteria in smears stained by Gram	Laboratory report	Interview, electronic tests
2.	Methods for microbiological diagnostics of shigellosis. Serologic diagnostics of typhoid and paratyphoid fever	–	3	–	2, 3, 6, 7, 9, 12	1. Recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria. 2. Performance and recording the slide agglutination test 3. Recording the tube agglutination test and indirect (passive)	Laboratory report	Interview, electronic tests

						hemagglutination for determining antibody titer		
3.	Methods for microbiological diagnostics of diseases caused by Klebsiella, Yersinia, Campylobacter, Pseudomonas. Principles of food poisoning diagnosis	–	3	–	2, 3, 6, 7, 9, 12	1. Determination of the morphotype of colonies on a slide nutrient medium in a Petri dish. 2. Microscopy of smears using an immersion system 3. Detection and determination of the morphology of Klebsiella in smears stained by Burri-Gins. 4. Performance and recording the slide agglutination test	Laboratory report	Interview, electronic tests
4.	Methods for microbiological diagnostics of diseases caused by Corynebacteria, Bordetella, hemoglobinophilic bacteria, Legionella, Listeria	–	3	–	2, 3, 6, 7, 9, 12	1. Preparation of a fixed smear from an agar culture of bacteria. 2. Staining a fixed smear with an aqueous solution of methylene blue. 3. Detection and determination of the morphology of corynebacteria in smears stained by Loeffler. 4. Microscopy of smears using an immersion system 5. Recording the tube agglutination test and indirect (passive) hemagglutination to determine the antibody titer	Laboratory report	Interview, electronic tests
5.	Methods for microbiological diagnostics of diseases caused by Actinomycetes and, Mycobacteria. Methods for microbiological diagnostics of anaerobic infections	–	3	–	2, 3, 6, 7, 9, 12	1. Microscopy of sputum smears stained by Ziehl-Neelsen to detect mycobacteria. 2. Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
6.	Especially dangerous infections. Methods for microbiological diagnostics of cholera, plague, tularemia, brucellosis, anthrax	–	3	–	2, 3, 6, 7, 9, 12	1. Microscopy of smears using an immersion system 2. Detection and determination of bacilli morphology in Gram-stained smears. 3. Detection and determination of	Laboratory report	Interview, electronic tests

						brucella morphology in Gram-stained smears. 4. Detection and determination of vibrio morphology in Gram-stained smears		
7.	Methods for microbiological diagnostics of diseases caused by Spirochetes	–	3	–	2, 3, 6, 7, 9, 12	Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
8.	Methods for microbiological diagnostics of diseases caused by Rickettsia and Chlamydia	–	3	–	2, 3, 6, 7, 9, 12	Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
9.	Methods for microbiological diagnostics of diseases caused by mycoplasmas. Concluding session «Special medical microbiology»	–	3	–	2, 3, 6, 7, 9, 12	1. Detection and determination of staphylococci morphology in Gram-stained smears. 2. Detection and determination of streptococci morphology in Gram-stained smears. 3. Detection and determination of enterobacteria morphology in Gram-stained smears. 4. Detection and determination of bacilli morphology in Gram-stained smears. 5. Detection and determination of brucella morphology in Gram-stained smears. 6. Detection and determination of vibrio morphology in Gram-stained smears. 7. Detection and determination of klebsiella morphology in Burri-Gins stained smears. 8. Detection and determination of gonococci morphology in pus smears stained by Gram. 9. Microscopic examination of	Laboratory report *	Electronic tests, colloquium*

						sputum smears stained by Ziehl-Neelsen to identify mycobacteria. 10. Detection and determination of the morphology of corynebacteria in smears stained by Loeffler. 11. Plating an isolated colony on slanted meat-peptone agar to accumulate a pure bacterial culture. 12. Recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria		
10.	Methods of viral infections diagnostics. Bacteriophages	–	3	–	2, 3, 6, 7, 9, 12	Recording the hemagglutination inhibition test for seroidentification of influenza viruses and serodiagnostics of viral infection	Laboratory report	Interview, electronic tests
11.	Methods for virological diagnostics of diseases caused by Orthomyxoviruses, Paramyxoviruses, Coronaviruses	–	3	–	2, 3, 6, 7, 9, 12	Recording the hemagglutination inhibition test for seroidentification of influenza viruses and serodiagnostics of viral infection	Laboratory report	Interview, electronic tests
12.	Methods for virological diagnostics of diseases caused by Picornaviruses, Rotaviruses, Retroviruses	–	3	–	2, 3, 6, 7, 9, 12			Interview, electronic tests
13.	Methods for virological diagnostics of diseases caused by arboviruses and viruses with natural focality	–	3	–	2, 3, 6, 7, 9, 12	Microscopy of smears using an immersion system	Laboratory report	Interview, electronic tests
14.	Methods for virological diagnostics of diseases caused by hepatitis viruses, herpes and adenoviruses	–	3	–	2, 3, 6, 7, 9, 12	Recording the results of the enzyme immunoassay (filling out the research protocol, assessing the reliability of the experiment and interpreting the results)	Laboratory report	Interview, electronic tests
15.	Oncogenic viruses. Etiology of slow infections. Prions and prion diseases. Concluding session «General and special medical virology»	–	3	–	2, 3, 6, 7, 9, 12	Recording the hemagglutination inhibition test for seroidentification of influenza viruses and serodiagnostics of viral infection	Laboratory report *	Electronic tests, colloquium*

16.	Clinical microbiology. Methods for microbiological diagnosis of purulent-septic infection of skin, subskin tissues, sepsis	–	3	–	2, 3, 6, 7, 9, 12	1. Compliance with aseptic rules when working with microorganisms of the 1st biological risk group. 2. Preparation of a fixed smear from an agar culture of bacteria. 3. Staining a fixed smear by Gram method. 4. Microscopy of smears using an immersion system	Laboratory report	Interview, written test, electronic tests
17.	Methods for microbiological diagnosis of purulent-septic infection of respiratory tract and urogenital tract. Nosocomial infections	–	3	–	2, 3, 6, 7, 9, 12	1. Preparation of a fixed smear from an agar culture of bacteria. 2. Staining a fixed smear by Gram method. 3. Microscopy of smears using an immersion system 4. Recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria	Laboratory report	Interview, electronic tests
18.	Methods for microbiological diagnostics of mycoses and protozoal diseases	–	3	–	2, 3, 6, 7, 9, 12	1. Microscopy of smears using an immersion system. 2. Detection and determination of Candida morphology in Gram-stained smears	Laboratory report	Interview, electronic tests
	Total hours	**27**	**105**	**9**				Exam

*This is a mandatory form of current certification.

INFORMATION AND METHODOLOGICAL UNIT

LITERATURE

Basic (relevant):

1. Generalov, I. I. Medical Microbiology, Virology & Immunology : textbook for foreign students of higher education institutions in the specialty «General Medicine», «Dentistry», «Pediatrics». In 2 parts. Part 1 / I. I. Generalov. – 2nd ed. – Vitebsk : VSMU, 2020. – 283 p.

2. Generalov, I. I. Medical Microbiology, Virology & Immunology : textbook for foreign students of higher education institutions in the specialty «General Medicine», «Dentistry», «Pediatrics». In 2 parts. Part 2 / I. I. Generalov. – 2nd ed. – Vitebsk : VSMU, 2020. – 401 p.

Additional:

3. Kirilchik, E. Yu. Микробиология, вирусология, иммунология = Microbiology, virology, immunology : workshop / E. Yu. Kirilchik [and others]. – Minsk: BSMU, 2024. – 132 p.

4. Kanashkova, T. A. Structure of bacterial cells. Microscopic examination of bacteria : teaching aid / T. A. Kanashkova [et al.]. – Minsk: BSMU, 2023. – 24 p.

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

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

7. Preclinical Immunology and Microbiology Review 2023: For USMLE Step 1 and COMLEX-USA Level 1 / eds. Tiffany L. Alley, Christopher C. Keller. – Kaplan Medical, a division of Kaplan North America, LLC., 2023. – 473 p.

8. Zverev, V. V. Medical Microbiology, Virology, Immunology: textbook : in 2 volumes. Vol. 1 / eds. V. V. Zverev, M. N. Boichenko. – Moscow : GEOTARMedia, 2022. – 384 p.

9. Zverev, V. V. Medical Microbiology, Virology, Immunology : textbook : in 2 volumes. Vol. 2. / eds. V. V. Zverev, M. N. Boichenko. – Moscow : GEOTARMedia, 2020. – 392 p.

10. Ostrovtsova, S. A. General microbiology: training appliance for students of foreign department / S. A. Ostrovtsova, A. I. Zhmakin. – 3rd ed. – Grodno : GrSMU, 2016. – 76 p.

11. Kozlova A.I. Methods of microbiological research: textbook-method. manual = Research methods in microbiology: educ. – method. manual. – Gomel : Gomel State Medical University, 2021. – 124 p.

Electronic courseware for the educational discipline «Microbiology, Virology, Immunology»

12. https://etest.bsmu.by/course/view.php?id=956.

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

The time allocated for independent work can be used by students for:
preparation for lectures and laboratory classes;
preparation for colloquia, credit and exam in the academic discipline;
study the topic submitted for the independent study;
preparation of thematic reports, reviews, presentations;
performance of practical tasks;
preparation of reports, abstracts;
preparation of tests for the organization of mutual control.

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

APPROXIMATE LIST OF TASKS FOR SUPERVISED STUDENT INDEPENDENT WORK:
preparation of thematic reports, reviews, presentations.

FORMS OF CONTROL OF SUPERVISED STUDENT INDEPENDENT WORK:
abstract defending;
electronic tests.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:
electronic test,
colloquium,
interviews,
laboratory report.

LIST OF AVAILABLE TEACHING METHODS

Linear (traditional) method;
active (interactive) methods:
Problem-Based Learning (PBL);
Team-Based Learning (TBL);
Research-Based Learning (RBL).

LIST OF PRACTICAL SKILLS

Name of practical skills	Form of practical skills control
1. Compliance with aseptic rules when working with microorganisms of biological risk group 1	Laboratory report
2. Plating an isolated colony on a slanted meat-peptone agar to accumulate a pure culture of bacteria	Laboratory report
3. Determination of the morphotype of colonies on a solid nutrient medium in a Petri dish	Laboratory report

Name of practical skills	Form of practical skills control
4. Recording the Mancini radial immunodiffusion reaction to determine immunoglobulin G concentration.	Laboratory report
5. Recording the results of the enzyme immunoassay (filling out the research protocol, assessing the reliability of the experiment and interpreting the results)	Laboratory report
6. Recording the results of the polymerase chain reaction (detection of amplification products, interpretation of results)	Laboratory report
7. Recording the tube agglutination test to determine the antibody titer	Laboratory report
8. Preparation of a fixed smear from an agar culture of bacteria	Laboratory report
9. Preparation of a fixed smear from a broth culture of bacteria	Laboratory report
10. Staining a fixed smear with an aqueous solution of fuchsin	Laboratory report
11. Staining a fixed smear with aqueous solution of methylene blue	Laboratory report
12. Staining a fixed smear by Gram method	Laboratory report
13. Microscopy of smears using an immersion system	Laboratory report
14. Detection and determination of morphology of staphylococci in Gram-stained smears	Laboratory report
15. Detection and determination of streptococcal morphology in Gram-stained smears	Laboratory report
16. Detection and determination of the morphology of enterobacteria in Gram-stained smears	Laboratory report
17. Detection and determination of bacilli morphology in Gram-stained smears	Laboratory report
18. Detection and determination of the morphology of Klebsiella in smears stained by Burri-Gins	Laboratory report
19. Detection and determination of morphology of gonococci in pus smears stained by Gram	Laboratory report
20. Detection and determination of vibrio morphology in Gram-stained smears	Laboratory report
21. Detection and determination of brucella morphology in Gram-stained smears	Laboratory report
22. Microscopic examination of sputum smears stained by Ziehl-Neelsen to detect mycobacteria	Laboratory report
23. Detection and determination of the morphology of Candida in Gram-stained smears	Laboratory report
24. Detection and determination of the morphology of corynebacteria in smears stained by Loeffler	Laboratory report

Name of practical skills	Form of practical skills control
25. Recording the biochemical activity of bacteria on a three sugars agar to identify enterobacteria	Laboratory report
26. Determination of sensitivity / resistance of bacterial culture to antibiotics by disk diffusion method (algorithm for conducting, recording, interpretation)	Laboratory report
27. Performance and recording the slide agglutination test	Laboratory report
28. Recording the reaction of indirect (passive) hemagglutination	Laboratory report
29. Recording the hemagglutination inhibition test for seroidentification of influenza viruses and serodiagnostics of viral infection	Laboratory report

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
1. Epidemiology	Epidemiology	No proposals	Protocol # 2 of 18.09.2024
2. Dermatovenereology	Dermatovenereology and cosmetology with advanced training and retraining courses	No proposals	Protocol # 2 of 18.09.2024
3. Phthisiopulmonology	Pulmonology, phthisiatry, allergology and occupational pathology with advanced training and retraining courses	No proposals	Protocol # 2 of 18.09.2024
4. Clinical Immunology, Allergology	Propaedeutics of Internal Diseases	No proposals	Protocol # 2 of 18.09.2024
5. Infectious Diseases	Infectious Diseases with advanced training and retraining courses	No proposals	Protocol # 2 of 18.09.2024
6. Pediatric Infectious Diseases	Pediatric Infectious Diseases with advanced training and retraining courses	No proposals	Protocol # 2 of 18.09.2024

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Senior teacher, Department of Microbiology, Virology, Immunology of the Educational Institution «Belarusian State Medical University» _____ N.I.Chekhovich

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

Head of the Office of Educational Activities of the educational institution «Belarusian State Medical University» _____ I.L.Kotovich
18.11.2024

Methodologist of the Educational and Methodological Department of the Office of Educational Activities of the educational institution «Belarusian State Medical University» _____ S.V.Zaturanova
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