

Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Institution of Higher Education
“National Research Nuclear University “MEPhI”

INSTITUTE OF ENGINEERING PHYSICS FOR BIOMEDICINE
DEPARTMENT OF FUNDAMENTAL MEDICINE

APPROVED ИТС ИФИБ

Protocol No. 3.1

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ACADEMIC COURSE OUTLINE

МЕДИЦИНСКИЕ МИКРОБИОЛОГИЯ И ВИРУСОЛОГИЯ / MEDICAL MICROBIOLOGY
AND VIROLOGY

Educational program track (specialty) [1] 31.05.01 General Medicine

Semester	Labour input, credits	Total course academic, hours	Lectures, hrs.	Practical sessions, hrs.	Laboratory sessions, hrs.	In the form of practical studies, hrs.	Independent studies, hrs.	Independent studies monitoring, hrs.	Course progress, Exam/Pass-fail exam/Term
3	3	108	16	0	56		36	0	PFE
4	4	144	14	0	66		28	0	Ex
Total	7	252	30	0	122	0	64	0	

ABSTRACT

The study of the discipline forms in future doctors a systematic knowledge of the structure, vital activity, ecology of microorganisms, the patterns of interaction with the human body and the role in the pathogenesis of infectious diseases. During the course of mastering the discipline, students gain practical skills in the methods of diagnosing infectious diseases and master the strategy of optimal use of the entire arsenal of methods for specific and non-specific prevention and treatment of infectious diseases.

In practical classes, students acquire the skills of modern methods of laboratory diagnostics of pathogenic microorganisms, interpretation of the results of microbiological, molecular genetic and immunological studies, as well as etiotropic treatment techniques, specific and non-specific prevention of infectious diseases. The discipline includes the section "Virology", where students gain basic knowledge about viruses and infectious diseases of viral etiology.

1. ACADEMIC COURSE GOALS AND OBJECTIVES

The purpose of studying the discipline:

- formation of systemic fundamental knowledge among future doctors about the structure, vital activity, ecology of microbes, identification of general patterns of interaction of microorganisms with the human body and their role in the pathogenesis of infectious diseases;
- mastering the methods of diagnosis of infectious diseases;
- study of the mechanisms of protection of the human body; mastering the strategy of optimal use of the entire arsenal of methods of specific and non-specific prevention and treatment of infectious diseases;
- improving the level of general and scientific development of students.

Objectives of the discipline:

- to study the biological features, physiology, genetics of pathogenic and opportunistic microbes; ecology and microecology of the main groups of medically significant microorganisms; to study the interactions of pathogenic and opportunistic microbes with the human body, the features of the pathogenesis of infectious diseases;
- provide the latest information and teach modern methods of laboratory diagnostics, interpretation of the results of microbiological, molecular genetic and immunological studies;
- to teach methods of etiotropic treatment, specific and non-specific prevention of infectious diseases; to study methods of obtaining and classifying immunobiological, chemotherapeutic, medical preparations and biotechnological products based on microorganisms or products of their vital activity;
- to highlight and promote the mastery of methods for detecting pathogenic microbes in environmental objects and anti-epidemic measures;
- develop students' skills in working with scientific literature;
- to familiarize students with the principles of organization of work in a microbiological laboratory, with occupational safety and health measures;

2. PLACE OF THE ACADEMIC COURSE IN THE MAIN HIGHER EDUCATION CURRICULUM

The discipline is implemented within the framework of the basic part

To successfully master the discipline, competencies are required that have been formed as part of the study of the following disciplines: • Chemistry; • Biochemistry; • Medical and biological physics; • Biology; • Latin language; • Anatomy; • Histology, cytology, embryology. The discipline is studied in the second year in the III and IV semesters.

3. DEVELOPED COMPETENCIES AND INTENDED LEARNING OUTCOMES

Universal and/or general professional competencies:

Competency code and title	Code and title of competency-based rubrics
OPIK-2 [1] – Capable of conducting and monitoring the effectiveness of measures for prevention, healthy lifestyle promotion, and sanitary-hygienic education of the population	3-OPIK-2 [1] – Know: - regulatory foundations for conducting preventive medical examinations and health check-ups; - rules for implementing sanitary and anti-epidemic measures; - forms and methods of health education work; - sanitary rules and regulations; - national immunization schedule; - main hazardous and harmful occupational factors. Y-OPIK-2 [1] – Be able to: - determine medical indications for imposing restrictive measures (quarantine) and conduct anti-epidemic measures in case of an infection outbreak; - conduct preventive medical examinations and health check-ups in accordance with current regulatory legal acts and other documents; - monitor the effectiveness of measures for disease prevention, health promotion, and sanitary-hygienic education of the population; - develop and implement health promotion programs aimed at eliminating harmful effects of environmental factors on human health; - establish cause-effect relationships between changes in health status and exposure to environmental factors. B-OPIK-2 [1] – Possess skills in: - organizing and conducting preventive medical examinations and health check-ups for the adult population to prevent the occurrence and/or spread of diseases and identify risk factors; - preparation (formation) and sending to the territorial office of the Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing an emergency notification upon detection of an infectious or occupational disease; -educating patients and their relatives on methods of self-monitoring key physiological indicators.
OPIK-5 [1] – Capable of assessing morphofunctional and physiological states, as well as pathological processes in the human body to solve professional tasks.	3-OPIK-5 [1] – Know: - basic medical, pharmaceutical, and morphofunctional terminology, including Latin terms; - structure and functions of the human body, age-related, gender-specific, and individual characteristics of the structure and development of a healthy organism; - physical and chemical nature of processes occurring in a living organism; - patterns of vital activity of the organism, mechanisms of self-regulation and regulation; - features of regulation of the functioning of human body systems in pathological conditions; - patterns of occurrence, development, and outcome of typical pathological processes, the concept of sanogenesis; - etiology and

	pathogenesis of the most common diseases; - the concept of nosology, principles of disease classification; - principles of microorganism classification, their morphology, physiology, and impact on human health; - structure and functions of the human immune system. Y-ОПК-5 [1] – Be able to: - analyze mechanisms of disease development and manifestation; - recognize morphological and functional changes in cells, tissues, organs, and systems of the human body; - use basic physical-chemical and other natural science concepts and methods in solving professional tasks; - determine the cause of death and formulate a pathological diagnosis. B-ОПК-5 [1] – Possess skills in: - conducting microscopy and analyzing microscopic specimens; - correlating morphological and clinical manifestations of diseases; - assessing morphofunctional, physiological states, and pathological processes in humans; - clinical-anatomical analysis of autopsy results.
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4. PEDAGOGIC POTENTIAL OF THE COURSE

Pedagogic tracks/objectives	Pedagogic goals (code)
Intellectual education	Establishing conditions for: formation of culture of intellectual work (B11)
Vocational and labor education	Establishing conditions for: formation of a deep understanding of the profession's social role, a positive and active commitment to the values of the chosen specialty, and a responsible attitude towards professional activity and work (B14)

5. ACADEMIC COURSE STRUCTURE AND CONTENT

Academic course sections, their scope, terms of study and assessment:

No.	Academic course section name	Weeks	Lectures/ Practical (seminars)/ Laboratory sessions, hrs.	Compulsory current assessment (form*, week)	Maximum grade per section**	Section assessment (form*, week)	Competency-based rubrics
	<i>3 Semester</i>						
1	General Microbiology. Section One	1-8	8/0/24	T-8 (25)	25	T-8	3-ОПК-2, Y-ОПК-2, B-ОПК-2, 3-ОПК-5, Y-ОПК-5,

							B-ОПК-5
2	General Microbiology. Section Two	9-15	8/0/32	T-15 (25)	25	T-15	3-ОПК-2, У-ОПК-2, B-ОПК-2, 3-ОПК-5, У-ОПК-5, B-ОПК-5
	<i>Totals for 3 Semester</i>		16/0/56		50		
	Assessment events for 3 Semester				50	PFE	У-ОПК-5, B-ОПК-5, 3-ОПК-2, 3-ОПК-5
	<i>4 Semester</i>						
1	Specialized Medical Microbiology and Virology. Section One	1-8	6/0/34	T-8 (25)	25	T-8	3-ОПК-2, У-ОПК-2, B-ОПК-2, 3-ОПК-5, У-ОПК-5, B-ОПК-5
2	Specialized Medical Microbiology and Virology. Section Two	9-15	8/0/32	T-15 (25)	25	T-15	3-ОПК-2, У-ОПК-2, B-ОПК-2, 3-ОПК-5, У-ОПК-5, B-ОПК-5
	<i>Totals for 4 Semester</i>		14/0/66		50		
	Assessment events for 4 Semester				50	Ex	3-ОПК-5, У-ОПК-5, B-ОПК-5, 3-ОПК-2

* – abbreviated name of assessment

** – 100 maximum points per semester including a pass/fail exam and (or) an exam

Abbreviated current assessment forms and section assessment

Abbreviation	Full name
T	Testing
PFE	Pass/fail examination
Ex	Exam

SYLLABUS

Weeks	Topics / Content	Lect., hrs.	Pr./sem., hrs.	Lab., hrs.
	<i>3 Semester</i>	16	0	56
1-8	General Microbiology. Section One	8	0	24
1 - 6	Morphology and classification of microbes Intramedical microbiology, its tasks, relation to other medical sciences. The emergence and development of microbiology. The role of Russian microbiologists in the development of	All		
		4	0	18
		Online		
		0	0	0

	world science. The spread of microbes in the environment. The role of microbes in living and inanimate nature. Principles of classification of microbes. Classification of bacteria by Bergey. Morphology of bacteria. Classification of bacteria by morphology. Modern approaches to the systematics of microorganisms. Taxonomic categories: kingdom, department, family, genus, species. Intraspecific categories: biovar, serovar, phagovar, morphovar, cultivar. Population, culture, strain, clone. Definition, application in theoretical and applied microbiology. Binary nomenclature of bacteria. Modern classification of bacteria: Archaeobacteria, Eubacteria, proteobacteria. Microbiological laboratory. Equipment, work rules, workplace organization. Methods of studying microorganisms (microscopic, bacteriological, experimental biological, serological, skin-allergic, molecular genetic). Microscopic examination method. Types of modern microscopes. Immersion microscopy. Basic methods for studying bacterial morphology. Microscopy using a light microscope, in a dark field, electron, phase contrast, luminescent, microscopy of colored and native preparations. Methods for the study of microbes in a living state. The main shapes (coccoid, rod-shaped, convoluted, branching), the size and relative location of bacteria. Tinctorial properties of bacteria. Simple (methylene blue and fuchsin) coloring methods. The stages of preparation of smear preparations. Features of the bacterial cell structure and its differences from cells of higher organisms. The main structures of a bacterial cell are the cell wall, cytoplasmic membrane, cytoplasm, and nucleoid (structure and chemical composition). The concept of complex coloring methods. The principle and stages of coloring according to the Gram method. The mechanism and stages of staining acid-resistant bacteria by the Zil-Nielsen method. The mechanism and stages of coloring according to Neisser, Burry-Gins, Ozheshka (Auyeski). Bacterial capsule, its purpose, methods of detection. Flagella, pili, cilia, structure, functions, methods of detection. Inclusions in bacteria, their identification. Bacterial spores, functions, detection methods. Subcellular forms of bacteria: protoplasts, spheroplasts, L-forms of bacteria. Bacterioscopic diagnostic method. The concept of eukaryotes and prokaryotes, representatives. Distinguishing features of eukaryotic and prokaryotic cells. Morphology of spirochetes, classification, structure, pathogenic representatives. Methods of studying spirochetes. Methods of coloring. Rickettsia. The systematic situation. Similarities with bacteria and viruses. Morphological types of rickettsias. Pathogenic representatives. Methods of coloring. Mycoplasma. The position among microorganisms. Features of morphology, importance in human pathology. Chlamydia. The position among microorganisms. Morphology, pathogenic representatives. Actinomycetes. The position among microorganisms. Features of morphology, importance in human pathology.			
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	Classification of fungi. Morphology of fungi, which are of the greatest importance in human pathology. The main forms of fungi (ovoid, micellar). Dimorphic mushrooms. The structure of mushrooms. Structural features of the cytoplasmic membrane and cell wall. Sporulation. Fungal spores (vegetative, endospores, exospores, sexual). Methods for studying the morphology of fungi (microscopy of native and stained preparations). Classification of protozoa. Morphology of protozoa. Pathogenic protozoa for humans, structural features, development cycles, biology. Staining methods for detecting trophozoites, cysts and other forms of protozoa. Morphology of viruses. Classification of viruses: human, animal, plant, and bacterial viruses. Principles of classification of human viruses (family, genus, species). The shapes and sizes of viruses, virion architecture, and viral inclusions. The concept of simple and complex viruses. Virion and its components. Nucleic acid, capsid, capsomers, core, supercapsid shell. Types of nucleocapsid symmetry. The physiology of viruses. Features of virus biology. Chemical composition of virions: nucleic acids, proteins, lipids, carbohydrates and their features. Enzymes of viruses. Types of virus-cell interaction: productive, abortive, integrative. Virogeny. Reproduction of viruses. The main stages of virus-cell interaction are: adsorption, characterization of viral ligands and cellular receptors; penetration into the cell, mechanisms; deproteinization; synthesis of viral macromolecules; assembly of virions; exit from the cell, exit routes. Interference. Defective interfering particles and their significance in the development of viral infection. Satellite viruses. The study of the morphology of microbes by microscopic method. The technique of working with a light microscope. The method of oil immersion in the diagnosis of pathogenic microorganisms.			
7 - 8	Physiology and genetics of microorganisms. The spread of microorganisms in the environment, the normal human microflora. Fundamentals of chemo and antibiotic therapy Physiology and genetics of microorganisms. The spread of microorganisms in the environment, the normal human microflora. Fundamentals of chemo and antibiotic therapy Enter Pathophysiology and genetics of microorganisms. The spread of microorganisms in the environment. Normal human microflora. Fundamentals of chemo- and antibiotic therapy. Isolation and identification of pure culture of microorganisms.	All		
		4	0	6
		Online		
		0	0	0
9-15	General Microbiology. Section Two	8	0	32
9 - 13	The physiology of microorganisms. The influence of physical, chemical and biological factors on microbes. Sterilization and disinfection. The ecology of microbes. Sanitary bacteriology. Exploring the	All		
		4	0	18
		Online		
		0	0	0

	The influence of physical factors on microbes (temperature, drying, environmental reactions, ultrasound, radiation). The influence of chemical factors of different classes on microbes. The influence of biological (symbiosis and antagonism) factors on microbes. The mechanisms of the damaging effect of these factors. Sterilization, methods, equipment, sterilization modes, sterilization control. Disinfection, methods, and groups of disinfectants. Current and final disinfection. The concept of disinsection and deratization. The concept of asepsis and antisepsis. The ecology of microbes. Scientific and social prerequisites for the formation of ecological microbiology. Natural microbiocenoses. Ecological connections in microbiocenoses. Symbiosis, commensalism, neutralism, competition, parasitism, predation. Dynamism of ecological relations. Ecological environments of microbes. Free-living and parasitic microbes. Soil microflora. Sources and ways of pathogenic microbes entering the soil. Conditions and terms of their survival in the soil. The role of free-living microorganisms in the formation and development of the Earth's biosphere. The participation of microbes in the biogeochemical cycles of chemical elements, the synthesis and transformation of organic substances, and the maintenance of the planetary radiation balance. Ecology of fungi: soil, phytopathogenic, zoophilic, anthropophilic. Sanitary-indicative soil microorganisms. Microflora of reservoirs. Sources and routes of pathogenic microbes entering water bodies. Conditions and terms of microbial survival in water. Microbiological indicators of drinking water quality. Microflora of atmospheric air, air of residential premises and medical institutions. Routes of entry, conditions and terms of microbial survival in the air. Sanitary-indicative microorganisms of the air. Microbiocenoses of food products. Sources and ways of pathogenic microbes entering food products. Conditions and terms of survival in them. Microbiological indicators of food quality. Microflora of household and industrial facilities and its role in the spread of infectious diseases. Principles of sanitary and microbiological research. Indication of pathogenic microbes in environmental objects, indirect methods: determination of total microbial contamination and sanitary-indicative microorganisms. Antibiotics. The concept of chemotherapy and antibiotics. The history of the development of chemotherapy. The role of P. Ehrlich, G. Domagk in the development of chemotherapy. A. Fleming, Z. Waxman, the history of the discovery of antibiotics (penicillin, streptomycin). The origin of antibiotics, their biological role in nature. Production methods (biological synthesis, chemical synthesis, combined method). Semi-synthetic antibiotics. Classification of antibiotics by chemical structure. The spectrum of action. Mechanisms of antimicrobial action: suppression of			
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peptidoglycan synthesis of the cell wall, synthesis of protein, nucleic acids, purines and amino acids, disorganization of the cytoplasmic membrane. Bactericidal (fungicidal) and bacteriostatic (fungiostatic) effects of antibiotics. Units of measurement of antimicrobial activity. Side effect of antibiotics. Complications of antibiotic therapy from the macroorganism: toxic effects of the drug, dysbiosis, allergic, immunosuppressive effects on the body, endotoxic shock. Principles of rational chemotherapy. Side effect on the microorganism: formation of atypical forms of microbes. Formation of antibiotic-resistant and antibiotic-dependent forms of microbes. Genetic and biochemical mechanisms of drug resistance. Ways to overcome the drug resistance of bacteria. Methods for studying the antibiotic sensitivity of bacteria in vitro (method of serial dilution, diffusion into agar). Antiviral chemotherapeutic drugs and interferon inducers, mechanisms of their antiviral action. Antifungal antibiotics and chemotherapeutic drugs (antimycotics). Antiprotozoal chemotherapeutic drugs. Bacteriophages. Virulent and moderate phages. Stages of interaction of bacteriophages with a cell. Lysogeny. Phage conversion. The practical use of bacteriophages in microbiology and medicine for the identification of bacteria (epidemiological labeling); for the treatment and prevention of infectious diseases, in the assessment of the sanitary state of the environment, in biotechnology. Phagotyping, methods of phage extraction from the studied material, methods of phage titration. The genetics of bacteria. Definition of bacterial genetics as a science. Its importance in the theory and practice of medicine. The organization of the genetic material in bacteria. The concept of genotype and phenotype. Bacterial chromosome. Structure, size, functional features, distinguishing features from the chromosome of eukaryotic cells. Functions of the chromosome. Principles of functioning of bacterial genes. Bacterial plasmids. Structure and features of replication. Types of plasmids: transmissible, nontransmissible, integrative, nonintegrative. The concept of plasmid compatibility. Determination of the presence of plasmids in a bacterial cell. Plasmid profile. Its application in epidemic labeling of bacteria. The phenotypic manifestation of plasmids. F-, R-, and Col plasmids. The role of R-plasmids in the spread of antibiotic resistance in the bacterial population. Plasmids of virulence. Their importance in the expression of pathogenicity factors. The use of plasmids in genetic engineering research. Mobile genetic elements: insertion sequences and transposons. Their structure. The functions of mobile genetic elements and their role in the evolution of bacteria. Types of variability in bacteria. Modification variability, its mechanisms and forms of manifestation. Genotypic variability. Mutations in bacteria, their varieties: spontaneous and induced,			
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	point and chromosomal aberrations; direct, reverse, suppressive. Causes and mechanism of mutations. The concept of mutagens. The phenotypic manifestation of mutations in bacteria. Repair processes in the bacterial cell. Their role in maintaining genome stability. Genetic recombination in bacteria. Differences from the genetic recombination of eukaryotes. Types of genetic recombination in bacteria: homologous, site-specific, illegal. Mechanisms of transmission of genetic information in bacteria: conjugation, transduction, transformation, their use to obtain recombinant bacterial strains with specified properties and mapping of the bacterial genome. Microbiological foundations of genetic engineering and biotechnology. The concept of restrictases, ligases and polymerases and the mechanisms of their action. Principles of creation of hybrid strains and their use as vaccine strains and strains producing biologically active substances. The use of genetic and molecular biological methods in the diagnosis of infectious diseases: PCR, the method of molecular probes, the method of "fingerprints". The genetics of viruses. The importance of virology in the development of genetics. The organization of the genetic apparatus of viruses. DNA and RNA are carriers of genetic information. Genetic variability of viruses: mutations and recombinations. Mutations, causes of occurrence. Phenotypic manifestations. Genetic interactions between viruses. Recombination. Genetic reactivation. Modification variability of viruses: complementation and phenotypic mixing. Techniques and methods of laboratory diagnostics of microorganisms that cause human diseases			
14 - 15	The doctrine of infection and the epidemiological process. The doctrine of immunity. General principles of treatment and prevention of diseases caused by microorganisms. Immunodiagnostic reactions (an The doctrine of infection and the epidemiological process. The doctrine of immunity. General principles of treatment and prevention of diseases caused by microorganisms. Immunodiagnostic reactions (antigen-antibody reactions Definition of the concept of "infection", "infectious process", "infectious disease". Conditions of the infectious process. Characteristic features of the infectious process. The role of microorganisms in the infectious process. Forms of micro- and macroorganism interaction: mutualism, commensalism, parasitism. Infection as a type of parasitism. The evolution of microbial parasitism. The concept of sapronosis. Pathogenicity of microorganisms, definition. Obligately pathogenic, conditionally pathogenic, non-pathogenic microorganisms. Virulence, definition, units of measurement (DLm, LD50, etc.). Pathogenicity factors of microorganisms: adhesives, pathogenicity enzymes; factors causing immunosuppression;	All		
		4	0	14
		Online		
		0	0	0

microbial toxins. Characteristics of pathogenicity factors. Toxicity and toxigenicity of bacteria. Protein toxins (exotoxins), classification, basic properties and mechanism of action. Units for measuring the strength of toxins (DLm, LD50). Endotoxins, chemical composition, properties, mechanism of action. The main differences from protein toxins. Allergens and microbial tolerance. Genetic control of pathogenicity factors in microorganisms. Heterogeneity of microbial populations based on virulence and pathogenicity factors. The role of plasmids in the expression of pathogenicity factors in microorganisms. The role of the macroorganism in the infectious process. The role of the host organism in the infectious process. The importance of the hereditary factor. Heterogeneity of the human population based on susceptibility to infection. The importance of gender, age, the state of the nervous and endocrine systems, as well as the influence of lifestyle, natural and social conditions of human life on the emergence, development and outcome of the infectious process. The concept of the pathogenesis of infectious diseases. Phases of the development of the infectious process: adhesion, colonization, invasion, microbial damage to cells and tissues. Medical immunology. Objectives and history of the development of immunology. Immunology as the science of methods and mechanisms of protection against genetically foreign substances in order to maintain the body's homeostasis. The emergence and formation of immunology as a science, the stages of the formation of immunology. The role of domestic and foreign scientists in the development of immunology, the role of immunology in the development of medicine and biology, its relationship with other sciences. The modern definition of the concept of "immunity". Types of immunity (innate, acquired, natural, artificial, active, passive, sterile, non-sterile, local, etc.). Non-specific human body protection factors. The concept of mechanical, physico-chemical and biological barriers. Mechanical protective reactions of the skin and mucous membranes. Physico-chemical protection of the body: The pH of the medium, the enzymatic activity of pepsin, etc. Biological protection factors. Phagocytosis. The role of I.I. Mechnikov in the development of the theory of phagocytosis. Classification of phagocytic cells, morphological features of neutrophils and macrophages. The main stages of phagocytosis, their characteristics. Complete and incomplete phagocytosis. The importance of phagocytosis in protecting the body from microbes and foreign agents. Humoral nonspecific protection factors: complement system, beta-lysines, interferons, leukins, antiviral serum inhibitors, lysozyme, plaquins, properdin, fibronectin, etc. Their physico-chemical and biological properties. The nomenclature of the main components of the complement			
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	system. Classical and alternative ways of complement activation. Antigens. Definition. The concept of antigenicity, immunogenicity and specificity. Conditions of antigenicity. Antigenic determinants, their structure. Conditions of immunogenicity. Classification of antigens. The biological role of antigens. Full-fledged antigens, haptens, synthetic antigens, and their properties. The human body's immune system and its main functions. The structure and functions of the immune system. Central organs of the immune system: bone marrow, thymus gland. Peripheral organs of the immune system: spleen, lymph nodes and follicles. Age-related features of the immune system. Cells of the immune system. Hematopoietic stem cells. The main cells of the immune system are T- and B-lymphocytes, macrophages (A-cells), and their ontogenesis. T-lymphocytes. Subpopulations of T cells. Products and functions of T-lymphocytes. B-lymphocytes. Subpopulations of B cells. Products and functions of B-lymphocytes. Antibodies and antibody formation. Antibodies. Definition. Physico-chemical, biological properties and functions. Immunoglobulins. The main classes, their structural and functional features. Constant and variable sections, domains. The structure of active centers of immunoglobulins and their main function. The mechanism of antibody-antigen interaction. The immune complex. Avidity and affinity of antibodies. The concept of antibody valence. Antigenic structure of immunoglobulins: isotypic, allotypic, idiotypic determinants. Antiidiotypic antibodies, Pathological immunoglobulins. Complete and incomplete antibodies. Genetics of immunoglobulins. Autoantibodies. The concept of monoclonal antibodies. Hybridomas. Biosynthesis of antibodies. Regulation of antibody formation. Dynamics of antibody formation, primary and secondary immune response. The biological role of various classes of immunoglobulins in the anti-infective protection of the body. Features of antibacterial, antiviral, antifungal, antiprotozoal, anthelmintic, antitumor, and transplant immunity. Immunological reactions in the diagnosis of infectious and non-communicable diseases. The concept of serological reactions. Characteristics of antigen–antibody reactions: specificity, two-phase character, reversibility, optimal ratio of ingredients, qualitative and quantitative character, sensitivity, etc. The mechanism of reactions. Practical use of serological reactions: identification of antigen, diagnostic detection of antibodies. The main components of serological reactions. Diagnostic immune serums, diagnostics. Monoclonal antibodies and their use. Phenomena of manifestation and methods of registration of serological reactions. Reactions based on the phenomenon of agglutination:			
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	agglutination (on glass and unfolded), indirect hemagglutination, reverse indirect hemagglutination, inhibition of hemagglutination, coagglutination, latex agglutination, Coombs reaction – antiglobulin test. Reactions based on the phenomenon of precipitation: annular precipitation, flocculation, gel precipitation (double counter immunodiffusion, radial immunodiffusion, immunoelectrophoresis). Reactions involving complement: immune lysis reactions (bacteriolysis, hemolysis); complement binding reaction; microbial immobilization reaction; opsonophagocytic reaction; neutralization reaction (of toxins, viruses, rickettsias). Reactions using labeled antigens and antibodies: immunofluorescence (direct and indirect Koons reaction); enzyme immunoassay (direct, indirect, solid-phase, competitive); radioimmune analysis (competitive, direct, indirect), immunoblotting. Immunoelectron microscopy (using antibodies labeled with ferritin, colloidal gold, isotopes).			
	<i>4 Semester</i>	14	0	66
1-8	Specialized Medical Microbiology and Virology. Section One	6	0	34
1 - 4	Pathogens of purulent-inflammatory diseases. Pathogens of airborne infections. Pathogens of anaerobic infection Pathogens of purulent-inflammatory diseases. Pathogens of airborne infections. Pathogens of anaerobic infection Pathogenic and opportunistic cocci. Classification, biological properties of staphylococci, streptococci, meningococci, gonococci. Pathogenesis, laboratory diagnostics, specific prevention and etiotropic therapy of the diseases they cause. Pathogenic corynebacteria. Characteristics of corynebacteria by Runyon. Biological properties of the causative agent of diphtheria. Pathogenesis, laboratory diagnostics, prevention, specific and etiotropic therapy of the diseases they cause. Biology of paogenic bordetella. Pathogenesis, clinic, diagnosis, treatment and prevention of whooping cough and paracoccussis. Pathogenic mycobacteria. Biological properties of the causative agent of diphtheria and tuberculosis. Pathogenesis, laboratory diagnostics, prevention, specific and etiotropic therapy of the diseases they cause. Pathogenic anaerobes. Classification. Biological properties of causative agents of tetanus, botulism, gas anaerobic infection. Pathogenesis, laboratory diagnostics, prevention, specific and etiotropic therapy of the diseases they cause	All		
		4	0	18
		Online		
		0	0	0
5 - 8	Causative agents of acute intestinal infections Causative agents of acute intestinal infections Pathogenic enterobacteria. Classification. General characteristics. Features of biology and morphology of enterobacteria. Biological properties of Escherichia coli,	All		
		4	0	16
		Online		
		0	0	0

	shigella and salmonella. Pathogenesis, laboratory diagnostics, prevention and etiologic therapy of the diseases they cause. The history of cholera pandemics. Pathogenic vibrios. Biological properties of vibrio cholerae. Pathogenesis, clinic, laboratory diagnostics, treatment and prevention of cholera. Features of morphology and biology of helicobacteriosis and campylobacteriosis pathogens. Pathogenesis, clinic, laboratory diagnostics, treatment and prevention of helicobacteriosis, campylobacteriosis.			
9-15	Specialized Medical Microbiology and Virology. Section Two	8	0	32
9	Zoonanthropous and especially dangerous infections (OOI) Zoonanthropous and especially dangerous infections (OOI) The concept of particularly dangerous infections. Features of professional behavior in the epidemics. Features of morphology and biology of OOI pathogens. Pathogenesis, clinic, laboratory diagnostics, treatment and prevention of especially dangerous infections.	All		
		2	0	4
		Online		
		0	0	0
10 - 11	Pathogens of vector-borne diseases and diseases of the external integument Pathogens of vector-borne diseases and diseases of the external integument The concept of particularly dangerous infections. Features of professional behavior in the epidemics. Features of morphology and biology of OOI pathogens. Pathogenesis, clinic, laboratory diagnostics, treatment and prevention of especially dangerous infections.	All		
		2	0	8
		Online		
		0	0	0
12 - 15	Private virology. Viruses are pathogens of diseases of various organs, systems and human tissues. Laboratory isolation and cultivation of viruses. Virosodiagnostics. Treatment and prevention of viral Private virology. Viruses are pathogens of diseases of various organs, systems and human tissues. Laboratory isolation and cultivation of viruses. Virosodiagnostics. Treatment and prevention of viral infections Orthomyxoviruses. Paramyxoviruses. Classification. General characteristics of influenza and measles viruses. Pathogenesis and laboratory diagnostics. Specific prevention of influenza and measles. Viruses are the causative agents of neurogenic infections. Classification. General characteristics of polio, rabies, and encephalomyelitis viruses. Pathogenesis, immunity, laboratory diagnostics and specific prevention of viral neurogenic infections. Viruses are the causative agents of hepatitis. Classification. General characteristics. Pathogenesis, immunity, laboratory diagnostics and prevention of viral hepatitis. Retroviruses. Classification. General characteristics of	All		
		4	0	20
		Online		
		0	0	0

	oncoviruses and HIV. Pathogenesis, laboratory diagnostics and prevention of HIV infection. The mechanism of viral carcinogenesis.			
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Abbreviated names of online options:

Abbreviation	Full name
EC	E-course
FtM	Full-text material
FtL	Full-text lectures
VM	Video materials
AM	Audio materials
Prs	Presentations
T	Tests
ERM	E-reference materials
IS	Interactive site

LABORATORY (LAB) SESSIONS TOPICS

Weeks	Topics / Content
	<i>3 Semester</i>
1 - 4	Basic laboratory testing methods Assessment of the bacteriological quality of milk using solid nutrient media, a reductase test, and a coli titer
5 - 8	General properties of microorganisms Study of morphological and cultural properties Gram staining
9 - 15	Physiological and biochemical properties of microorganisms Decomposition of natural nitrogen-free compounds Participation of microorganisms in the nitrogen cycle. Sowing on liquid nutrient media
	<i>4 Semester</i>
1 - 8	Pathogens and opportunistic pathogens Studying the morphology of pathogenic microorganisms on fixed preparations
9 - 15	Antibiotic susceptibility Two methods for assessing the susceptibility of microorganisms to antibiotics

6. EDUCATIONAL TECHNOLOGIES

Information and communication (ICT) technologies.

Modular technology (lecture and seminar system) - lectures; practical and laboratory classes; independent work of students; intermediate control; exam.

Case technology is the solution of situational problems.

The research method of teaching is writing abstracts.

7. ASSESSMENT TOOLKIT

The assessment toolkit ensures verification of the intended learning outcomes achievement (competency-based rubrics) using current, midterm and interim assessment of the course.

The link between developed competencies and their assessment is presented in the following table:

Competency	Achievement rubrics	Assessment activity (Syl 1)	Assessment activity (Syl 2)
ОПК-2	3-ОПК-2	PFE, T-8, T-15	Ex, T-8, T-15, T-8, T-15
	Y-ОПК-2	T-8, T-15, T-8	T-8, T-15
	B-ОПК-2	T-8, T-15	T-8, T-15
ОПК-5	3-ОПК-5	PFE, T-8, T-15	Ex, T-8, T-15
	Y-ОПК-5	PFE, T-8, T-15	Ex, T-8, T-15
	B-ОПК-5	PFE, T-8, T-15, T-15	Ex, T-8, T-15

Educational achievement rubrics scales

The scale of each assessment activity varies from 0 to the maximum established point, inclusive. The final assessment of the course is performed on a 100-point scale and represents the sum of the points earned by the student in the section assessments, framework of current and interim assessment.

Sections and interim assessments are considered passed when the student achieves a minimum score equal to 60% of the maximum. The final grade is assigned only upon passing all sections and the interim assessment.

The final grade is assigned in accordance with the following scale:

Total score	Rating on a 4-point scale	Pass/fail examination	ECTS assessment
90-100	5 – « <i>excellent</i> »	« <i>pass</i> »	A
85-89	4 – « <i>good</i> »		B
75-84			C
70-74			D
65-69	3 – « <i>satisfactory</i> »		E
60-64			F
below 60	2 – « <i>fail</i> »	« <i>fail</i> »	

An “excellent” grade indicates a deep and solid mastery of the program material by a student who presents their answers consistently, clearly, and logically, is able to closely link theory with practice, and uses materials from monographic literature in their answers.

A “good” grade corresponds to a student’s solid knowledge of the material, who presents their answers competently and to the point, without any significant inaccuracies.

A “satisfactory” grade corresponds to the basic level of mastery of the material by the student, in which the main material has been mastered, but its details have not been assimilated, the answers contain inaccuracies, insufficiently correct wording and logical inconsistencies.

A grade “pass” corresponds to at least a basic level of mastery of the program material, in which the student possesses the necessary knowledge, skills, and abilities, and is able to apply theoretical principles to solve typical practical problems.

A grade “fail” is given to a student who lacks a significant understanding of the curriculum material, makes significant errors in their answers, or fails all required assignments. These students are generally unable to continue their studies without additional classes.

8. ACADEMIC COURSE EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT

CORE READING:

1. ЭИ М45 Medical Microbiology, Virology, Immunology : textbook : Vol. 2. : учебник, Boichenko M.N., Zverev V.V., Москва: ГЭОТАР-Медиа, 2020
2. ЭИ Z96 Medical Microbiology, Virology, Immunology : textbook. Vol. 1 : , Boichenko M.N., Zverev V.V., Москва: ГЭОТАР-Медиа, 2022
3. ЭИ М42 Медицинская микробиология, вирусология и иммунология : Т. 1 : Рекомендовано ФГАУ "Федеральный институт развития образования" в качестве учебника для использования в учебном процессе образовательных организаций, реализующих программы высшего образования по специальностям 31.05.01 "Лечебное дело", 31.05.02 "Педиатрия", 32.05.01 "Медико-профилактическое дело", Бойченко М.Н, Зверева В.В., Москва: ГЭОТАР-Медиа, 2020
4. ЭИ М42 Медицинская микробиология, вирусология и иммунология : Т. 2 : Рекомендовано ФГАУ "Федеральный институт развития образования" в качестве учебника для использования в учебном процессе образовательных организаций, реализующих программы высшего образования по специальностям 31.05.01 "Лечебное дело", 31.05.02 "Педиатрия", 32.05.01 "Медико-профилактическое дело", Бойченко М.Н., Зверева В.В., Москва: ГЭОТАР-Медиа, 2021

FURTHER READING:

1. ЭИ М42 Medical Microbiology, Virology and Immunology. Lecture Notes : , Potaturkina-Nesterova N.I., Ilyina N.A., Nemova I.S., Москва: ГЭОТАР-Медиа, 2021
2. ЭИ Х 15 Иммунология : учебное наглядное пособие, Ярилин А.А., Хаитов Р.М., Пинегин Б.В., Москва: ГЭОТАР-Медиа, 2011
3. ЭИ И 74 Инфекционные болезни. Национальное руководство : краткое издание, монография, , Москва: ГЭОТАР-Медиа, 2020
4. ЭИ М59 Микробиология, вирусология, иммунология полости рта : учебник, Царев В.Н., Москва: ГЭОТАР-Медиа, 2019

SOFTWARE:

1. Microsoft Office 2016+ ()

LMS AND ONLINE RESOURCES

1. The course of medical microbiology and virology (<https://online.mephi.ru/course/view.php?id=873>)

<https://online.mephi.ru/>

<http://library.mephi.ru/>

9. LOGISTICAL SUPPORT

1. Бинокулярные микроскопы "Микромед 2" (64-501)
2. Персональный компьютер: Моноблок Lenovo V540-24IWL All-In-One 23,8" i3-8145U 8Gb 256GB_SSD_M.2 Intel (64-501)
3. Проектор SMART P109 (64-501)
4. Мебель лабораторная, стулья, шкафы для хранения (64-501)
5. Интерактивная доска SMART SBM 685 (64-501)
6. Мышь, клавиатура (64-501)
7. Мойка лабораторная (64-502)
8. Лаборатория с оснащением, обеспечивающим проведение практической подготовки по микробиологии (64-503)

10. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR STUDENTS

Lecture:

Writing lecture notes: briefly, schematically, consistently record the main points, conclusions, formulations, generalizations; mark important thoughts, highlight keywords, terms. Checking terms and concepts with the help of encyclopedias, dictionaries, reference books with writing out interpretations in a notebook. Identify the questions, terms, and material that causes difficulties, mark them, and try to find an answer in the recommended literature. If you can't figure out the material on your own, you need to formulate a question and ask the teacher for a consultation or a practical lesson.

Independent work:

Each student should individually prepare for the topics of the discipline by reading lecture notes and recommended literature. Independent work allows the student to think in a calm environment, sort out information on the topic, and, if necessary, refer to the reference literature. Careful reading and repetition of what has been read helps to fully assimilate the content of the topic and structure knowledge.

In order for meaningful information on the discipline to be remembered for a long time, it is advisable to study it in stages - by topic and in strict sequence, since subsequent topics, as a rule, rely on previous ones. That is why most of the independent work involves preparing for seminars, completing recommended tasks, preparing for colloquiums, completing and defending individual

homework, as well as preparing for laboratory work. To successfully complete these tasks, each student has the opportunity to use the methodological support developed at the department.

It is best for students to plan the time for independent work required to study this discipline for the entire semester, while providing for regular repetition of the material they have studied. The material reviewed in the lectures should be regularly supplemented with information from literary sources presented in the discipline's work program. For each of the self-study topics listed in the discipline's work program, you should first read the recommended literature and, if necessary, make a brief summary of the main provisions, terms, and information that require memorization and are fundamental in this topic and for mastering subsequent sections of the course. It is recommended to use online resources to expand knowledge of the discipline.

When working independently, it is recommended to take notes on the studied (studied) material. The summary can be basic, contain only the main key points, but at the same time be sufficient for a complete answer to the question. The summary can be detailed. The volume of the summary is determined by the student himself.

In the process of working with educational / scientific literature, the student is recommended to take notes on the course of reading in the form of a simple or detailed plan, to compose abstracts, to prepare annotations of what he has read. The presence of such notes can give additional points for activity.

Laboratory classes:

Elaboration of the work program, paying special attention to the goals and objectives, structure and content of the discipline. Taking notes on sources. Working with lecture notes, preparing answers to control questions, reviewing recommended literature, and working with textbook text. Listening to audio and video recordings on a given topic, solving computational and graphical tasks, solving problems using an algorithm, etc.

Control work:

Familiarization with the main and additional literature, including reference publications, foreign sources, a summary of the main provisions, terms, information required for memorization and which are fundamental in this topic. Making annotations to read literary sources, etc.

Report:

The search for literature and the compilation of a bibliography, the use of 3 to 5 scientific papers, the presentation of the opinion of the authors and their judgment on the selected issue; the presentation of the main aspects of the problem. To get acquainted with the structure and design of the abstract.

Exam preparation:

When preparing for the exam (assessment), it is necessary to focus on lecture notes, recommended literature, etc.

11. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR TEACHERS

The structure of the laboratory lesson in the discipline:

1. Definition of the topic and purpose of the laboratory lesson – 5 minutes;
2. Discussion of issues that caused difficulties in preparing for the laboratory lesson - 10 min.
3. Control of theoretical knowledge through testing – 15 min.
4. Discussion of theoretical issues (Questions for discussion) – 45 min.
5. Laboratory work under the guidance of a teacher, preparation of a report – 45 min.
6. Check the completion of the laboratory work (report) – 15 minutes.

The teaching of the discipline "Medical microbiology and virology" using a pillbox is provided.:

- conducting distance learning using Skype, Zoom;
- the educational and methodological materials necessary for training are placed in the University's distance learning system, the Educational Portal (OP) of the National Research Nuclear University "MEPhI".
- knowledge testing using tests is carried out on the Educational Portal of the National Research Nuclear University MEPhI and OnlineTestPad.

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