Application #1 to the Course Outline

Federal State Budgetary Educational Institution of Higher Education Ural State Medical University
Ministry of Healthcare of the Russian Federation

Department of Medical Microbiology and Clinical Laboratory Diagnostics

УТВЕРЖДАЮ
Проректор по образовательной деятельности
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Fund of Assessment Tools

Microbiology, Virology, Immunology

Major: General Medicine
Qualification: General Practitioner

Yekaterinburg
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1. Codifier of learning outcomes for the discipline

Category (Group) of General Professional Competencies	Code and Name of General Professional Competency	Code and Name of Indicator of Achievement of General Professional Competency	Index of Labor Function and Its Content	Didactic Unit (DU) and Codes of Competency	Controlled Learning Elements			Methods for assessing the results of mastering a discipline
					Knowledge	Abilities (Skills)	Proficiencies (Competencies)	
Etiology and pathogenesis	OPK-5. Capable of assessing morphofunctional, physiological states, and pathological processes in the human body to solve professional problems.	ID-1OPK-5. Can: analyze the structure, topography, and development of cells, tissues, organs, and organ systems in relation to their function in health and disease, as well as the anatomical, physiological, age-related, gender-specific, and individual characteristics of the structure and development of healthy and diseased organisms. ID-2OPK-5. Can: evaluate	A/02.7 – Conducting a patient examination to establish a diagnosis A/05.7 – Conducting and monitoring the effectiveness of measures to prevent and promote a healthy lifestyle and provide public health education	DU1 - DU6	- Safety regulations for working in a microbiology laboratory with infectious material, reagents, equipment, and laboratory animals - Classification, morphology, physiology, ecology, and genetics of microorganisms, their impact on human health, and microbiological diagnostic methods - Structure and functions of the human immune system, its age-related characteristics, and cellular and humoral factors of the body's immune system - Patterns of development of anti-infective	- use of educational and scientific literature, and online information resources for professional activities - preparation of fixed smears from broth and agar bacterial cultures - staining of smears using simple and complex methods - microscopy of preparations using an immersion system - inoculation of test material onto nutrient media - interpretation of antibiogram results	- knowledge of microbiological concepts - description of the morphological, cultural, and biochemical characteristics of microorganisms	Codifier of learning outcomes for the discipline

		morphofunctional and physiological indicators based on the results of a patient's physical examination. ID-3OPK-5. Can: evaluate morphofunctional and physiological indicators based on the results of a patient's laboratory and instrumental examination. ID-4OPK-5. Can: substantiate morphofunctional characteristics, physiological states, and pathological processes in the human body to solve professional problems.			immunity, mechanisms of immune response development - Mechanisms of development of immunopathological reactions and immunodeficiencies - Main antibacterial, antifungal, and antiviral drugs - Types of vaccines and main antibody preparations used to treat or prevent infectious diseases - Principles of sample collection and stages of microbiological testing - Methods of disinfection of infected material and environmental objects contaminated with pathogenic microorganisms - Main pathogenetic mechanisms of infectious disease development			

2. Assessment Materials

2.1 Format of Midterm Assessments

Midterm assessments are conducted in the format of a blitz survey (rapid-fire oral questioning).

2.2 Preparation Questions for Midterm Assessments

The preparation questions for the midterm assessments correspond to the questions for the intermediate certification, organized by course sections (see section 2.4):

- Midterm Assessment 1 – Question Block 1
- Midterm Assessment 2 – Question Block 2
- Midterm Assessment 3 – Question Block 3
- Midterm Assessment 4 – Question Block 4
- Midterm Assessment 5 – Question Blocks 5 and 6

2.3 Description of the Methodology for Evaluating Midterm Assessment Results

The student answers questions from the corresponding section in a blitz format. The provided response is evaluated on a 5-point scale according to the following criteria:

- "Excellent" – 5 points
    - The student demonstrates a deep understanding of the fundamental processes within the subject area. The answer is characterized by its comprehensive coverage of the topic; the student commands the relevant terminology; the response is logical and sequential. The student is able to explain the essence of phenomena, processes, and events with argumentation, can analyze, draw conclusions, make generalizations, and provide examples; can justify the choice of problem-solving methods and demonstrates problem-solving skills.
- "Good" – 4 points
    - The student demonstrates knowledge of the fundamental processes at a basic level, and the answer is generally complete in covering the topic; the student commands the terminology and is fluent in monologue speech. However, minor inaccuracies may be present in the answer. The student can explain the essence of phenomena, processes, and events, draw conclusions, make generalizations, provide reasoned answers, and give examples, but may do so with some inaccuracies and may experience difficulty in answering follow-up questions.
- "Satisfactory" – 3 points
    - The student demonstrates insufficient knowledge to fully explain the observed processes in the subject area. The answer lacks completeness in covering key theoretical and practical aspects, and contains errors in content. The student demonstrates the ability to provide reasoned answers and give examples only at a threshold level.
- "Unsatisfactory" – 2 points

- The student demonstrates a weak grasp of the subject area and lacks the ability to analyze and explain observed phenomena and processes. The answer contains serious errors and shows a lack of understanding of the core issues. Many of the assignment requirements are not met. The student lacks the ability to substantiate answers or provide relevant examples.

2.4 Questions for Intermediate Certification

Block 1: General Microbiology

1. The subject of microbiology, main groups of microorganisms and infectious agents.
2. Nomenclature and taxonomy of bacteria. Phenotypic and genotypic identification of bacteria. Identification of bacteria using the 16S ribosomal RNA gene.
3. Morphology and ultrastructure of prokaryotes. Functions of individual structures of the bacterial cell.
4. Structure and function of the cell wall in Gram-positive and Gram-negative bacteria, and mycobacteria.
5. Bacterial pili and flagella: structure and functions.
6. Bacterial capsules. Composition and functions of capsules. Methods for visualizing capsules. Examples of encapsulated pathogenic bacteria.
7. Sporulation in bacteria. Chemical composition of spores. Resistance of spores to physical and chemical factors. Methods for visualizing spores. Examples of spore-forming pathogenic bacteria.
8. Aerobic, microaerophilic, and anaerobic bacteria. Features of cultivation and growth. Examples of pathogens.
9. Mechanisms of bacterial reproduction. Rate and phases of bacterial culture growth in liquid nutrient medium.
10. Bacterial biofilms. Stages and conditions of formation. Quorum sensing. Composition of the extracellular matrix. Role of bacterial biofilms in pathology development.
11. Principle of Baltimore virus classification and features of retrovirus reproduction.
12. Morphology, ultrastructure, and chemical composition of enveloped and non-enveloped viruses.
13. Entry of enveloped and non-enveloped viruses into target cells. Viral tropism. Concept of cell susceptibility and permissiveness.
14. Reproduction of viral genomes and virion assembly. Lytic and latent viral infections. Integration of viral genomes.
15. Infectious and non-infectious viral particles. Measurement of virus infectivity.
16. Virulent and temperate bacteriophages. Stages of bacteriophage reproduction. Prophage. Lysogeny. Phage conversion.
17. Bacterial chromosomes, pathogenicity islands, and mobile genetic elements in bacteria. Role of mobile genetic elements in increasing pathogen virulence and developing drug resistance.

18. Mechanisms of phenotypic and genotypic variability of microorganisms. Spontaneous and induced mutations. Mutation rates in bacteria and viruses.
19. Recombination and reassortment of viral genomes. Role of recombination and reassortment in the emergence of new variants of pathogenic viruses.
20. Mechanisms of DNA transfer between bacterial cells: transformation, transduction (generalized and specialized), conjugation.
21. Stages of creating genetically modified bacteria and yeast as producers of biomedical preparations.
22. Symbiosis, mutualism, commensalism, and parasitism.
23. Human microbiota and microbiome: definition and main functions (using the gut as an example).
24. Distribution of microorganisms in the healthy human body: biotopes with high and low microbial load, sterile biotopes.
25. Main representatives of the resident microbiota of the intestine, urogenital tract, skin, respiratory tract. Significance in physiological processes. Age-related changes.
26. Concept of dysbiosis. Main manifestations of intestinal and vaginal dysbiosis. Principles of dysbiosis correction. Conditions for occurrence and examples of diseases caused by opportunistic microorganisms.
27. Prebiotics, probiotics, synbiotics, metabiotics.
28. Phenotypic and genotypic methods for assessing microbiota. Concept of alpha and beta diversity of microbiota.
29. True pathogens and opportunistic microorganisms: definitions and examples.
30. Bacterial pathogenicity factors: adhesins, invasins, antiphagocytic factors, aggression enzymes.
31. Endotoxin. Chemical nature and biological properties. Mechanism of impact on the human body. Septic shock.
32. Chemical and biological properties of exotoxins. Mechanism of action of individual groups of bacterial exotoxins. Examples of toxigenic microorganisms.
33. Infectious disease, its features. Conditions for the occurrence of an infectious disease. Periods of an infectious disease. Outcomes of an infectious disease.
34. Concept of the portal of entry. Routes of spread of microorganisms and their toxins in the body. Types of generalized infectious processes.
35. Forms of infection manifestation. Persistence of bacteria and viruses. Concept of relapse, reinfection, mixed infection, superinfection, secondary infection.

Block 2: Immunology

1. Mechanisms of antimicrobial action of physiological barriers.
2. Properties and dynamics of the innate and adaptive immune system responses.
3. Central and peripheral organs of the immune system: structure, role in the development of immune system cells, functional features.
4. Recognition of infection by the innate immune system: PAMPs, DAMPs, PRRs.
5. Antigen presentation: role of Major Histocompatibility Complex molecules and MHC restriction of T-lymphocytes.

6. Humoral factors of the innate immune system: complement and interferons. Mechanisms of antimicrobial and immunomodulatory action. Role in protection against pathogenic microorganisms.
7. Cells with phagocytic activity. Neutrophils. The mononuclear phagocyte system. Role of phagocytes in the development of the immune response.
8. Antigen-dependent and antigen-independent differentiation of T and B lymphocytes. Specificity of the adaptive immune response.
9. Recognition of infection by the adaptive immune system: antigens, activation and clonal expansion of lymphocytes.
10. Structure, functions, and biological properties of individual immunoglobulin classes.
11. Cytotoxic lymphocytes: CD8 lymphocytes and NK cells. Mechanism of cytotoxicity. Role in protection against pathogenic microorganisms.
12. Type 1 hypersensitivity. Conditions and mechanism of development. Examples of diseases. Desensitization.
13. Type 2 hypersensitivity. Conditions and mechanism of development. Examples of diseases.
14. Type 3 hypersensitivity. Conditions and mechanism of development. Examples of diseases.
15. Type 4 (delayed) hypersensitivity. Conditions and mechanism of development. Role in protection against pathogens and in disease development.
16. Immunological tolerance: definition, formation, significance. Mechanisms of autoimmune disease development.
17. Primary and secondary immunodeficiencies (causes leading to their development, diagnostic methods, correction methods).

Block 3: Principles of Diagnosis, Treatment and Prevention of Infectious Diseases

1. Organization of a microbiological laboratory and pathogenicity groups of microorganisms. Rules for working with Hazard Group 3-4 agents, concept of "clean" and "dirty" zones in the laboratory, direction of biomaterial flow.
2. Features of diagnosing infections caused by obligate and opportunistic pathogens.
3. Direct and indirect methods of laboratory microbiological diagnosis of infectious diseases.
4. Bright-field microscopy, dark-field microscopy. Fluorescence microscopy. Principles, capabilities, and limitations of the methods.
5. Methods for staining bacterial specimens. Staining with methylene blue. Gram stain method. Ziehl-Neelsen method. Principles of the methods. Application.
6. Direct and indirect immunofluorescence reactions. Principle of the method. Application. Capabilities and limitations of this technique in diagnosing infectious diseases.
7. Cultural method. Principle of the method. Isolation of pure culture. Features of cultivating aerobic and anaerobic microorganisms.

8. Nutrient media: simple, complex, elective (selective), differential-diagnostic, synthetic. Growth pattern of microorganisms in liquid and solid nutrient media. Bacterial colonies, their characteristics.
9. Features of cultural diagnosis from sterile biomaterials and biomaterials with high microbial load. Most important pathogenic anaerobes.
10. Classical, mass-spectrometric and molecular-genetic methods for genus, species, and intraspecies identification of isolated microbial cultures.
11. Capabilities and limitations of classical and accelerated cultural methods in diagnosing infectious diseases.
12. Principle of the polymerase chain reaction method. Components of the reaction mixture. Accumulation and visualization of amplicons.
13. Real-time polymerase chain reaction and reverse transcription polymerase chain reaction. Features of the techniques. Application in diagnosing infectious diseases.
14. Capabilities and limitations of the polymerase chain reaction method in diagnosing infectious diseases.
15. Capabilities and limitations of direct and indirect immunodiagnostic methods for infectious diseases.
16. Enzyme-linked immunosorbent assay and immunoblotting. Principles of the methods and features of interpreting the obtained results.
17. Skin tests with antigens in the diagnosis of infectious diseases (allergy tests). Principle of the method. Examples of infections and used preparations. Capabilities and limitations of the technique.
18. Principle, capabilities, and limitations of IGRA tests (interferon-gamma release assays) in diagnosing infectious diseases.
19. Antibacterial drugs. Main molecular targets and drug classes affecting them. Side effects on the body.
20. Main groups of antiviral drugs: mechanism of action and side effects on the body.
21. Main groups of antifungal drugs: mechanism of action and side effects on the body.
22. Bacterial drug resistance. Genotypic and phenotypic mechanisms of emergence. Concept of selection of resistant strains.
23. Principles, capabilities, and limitations of phenotypic and genotypic tests for determining bacterial resistance to antimicrobial drugs.
24. Methods for determining the minimum inhibitory concentration of antimicrobial drugs and their application in clinical practice.
25. Antibiotic-modifying enzymes of bacteria: mechanism of action, methods of detection, and spread of genes encoding them in bacterial populations.
26. Disk diffusion (Kirby-Bauer) method for determining susceptibility to antimicrobial drugs and categories of bacteria based on susceptibility to antimicrobial drugs.
27. Sterilization. Sterilization methods. Capabilities and limitations of individual sterilization methods.
28. Disinfection. Disinfection methods. Main groups of disinfecting and antiseptic substances with their mechanisms of action.

29. Sources of infection, mechanisms, routes, and factors of transmission. Conditions for the spread of infection in human communities. Principles of combating infectious diseases.
30. Herd immunity and its role in preventing the spread of infectious disease.
31. Composition and methods of obtaining attenuated, inactivated, subunit, recombinant adenoviral, and mRNA vaccines.
32. Reactogenicity and immunogenicity of different vaccine types: influence of vaccine composition and the role of adjuvants.
33. Advantages and disadvantages of attenuated, inactivated, subunit, recombinant adenoviral, and mRNA vaccines.
34. Features of the immune response to different types of vaccines.
35. Toxoids and viral subunit vaccines: methods of production, composition, mechanism of action, and application in the prevention of infectious diseases.
36. Conjugated polysaccharide vaccines: methods of production, composition, mechanism of action, and application in the prevention of infectious diseases.
37. Polyclonal antitoxic sera and immunoglobulins: methods of production, composition, mechanism of action, application in the treatment and prevention of infectious diseases.
38. Antiviral immunoglobulins: methods of production, composition, mechanism of action, application in the treatment and prevention of infectious diseases.
39. Monoclonal antibodies: methods of production and application in medicine.

Block 4: Special Bacteriology

Approximate characterization of the pathogen and the disease it causes:

- Classification, morphology, and staining properties
- Resistance in the environment
- Sources of infection, mechanisms, routes, and factors of transmission
- Pathogenesis of the disease, main clinical manifestations, immunity
- Laboratory diagnostics
- Principles of treatment
- Non-specific and specific prevention

1. Staphylococci
2. Enterococci
3. Beta-hemolytic streptococci
4. Pneumococci
5. Meningococci
6. Gonorrhea pathogen (*Neisseria gonorrhoeae*)
7. Anthrax pathogen (*Bacillus anthracis*)

8. Agents of anaerobic wound infection (gas gangrene)
9. Botulism pathogen (*Clostridium botulinum*)
10. Tetanus pathogen (*Clostridium tetani*)
11. Diphtheria pathogen (*Corynebacterium diphtheriae*)
12. Tuberculosis pathogens (*Mycobacterium tuberculosis* complex)
13. Actinomycetes
14. Diarrheagenic *Escherichia coli*
15. Dysentery pathogens (*Shigella* spp.)
16. Typhoidal salmonellae (*Salmonella* Typhi, Paratyphi)
17. Non-typhoidal salmonellae
18. Campylobacters
19. Helicobacters (*Helicobacter pylori*)
20. Enteric yersiniae (*Yersinia enterocolitica, Y. pseudotuberculosis*)
21. Cholera pathogen (*Vibrio cholerae*)
22. Whooping cough pathogen (*Bordetella pertussis*)
23. Haemophilus influenzae
24. Pseudomonads and Acinetobacters
25. Plague pathogen (*Yersinia pestis*)
26. Tularemia pathogen (*Francisella tularensis*)
27. Brucellosis pathogens (*Brucella* spp.)
28. Bacteroides
29. Syphilis pathogen (*Treponema pallidum*)
30. Agent of systemic tick-borne borreliosis (*Borrelia burgdorferi* sensu lato)
31. Chlamydiae
32. Mycoplasmas and Ureaplasmas
33. Legionellae
34. Leptospires
35. Epidemic typhus pathogen (*Rickettsia prowazekii*)
36. Listeriae (*Listeria monocytogenes*)

Block 5: Special Virology

Approximate characterization of the pathogen and the disease it causes:

- Classification, virion structure
- Replication cycle and resistance in the environment
- Sources of infection, mechanisms, routes, and factors of transmission
- Pathogenesis of the disease, main clinical manifestations, immunity
- Laboratory diagnostics
- Principles of treatment
- Non-specific and specific prevention

1. Influenza viruses
2. Coronaviruses
3. Rhinoviruses
4. Respiratory syncytial virus
5. Parainfluenza viruses
6. Adenoviruses
7. Measles virus
8. Rubella virus
9. Mumps virus
10. Polioviruses
11. Non-polio enteroviruses
12. Human papillomaviruses
13. Herpes simplex viruses
14. Varicella-Zoster virus
15. Epstein-Barr virus
16. Cytomegalovirus
17. Human herpesviruses 6 and 7
18. Human herpesvirus 8
19. Hepatitis A virus
20. Hepatitis B virus
21. Hepatitis C virus
22. Hepatitis D virus
23. Hepatitis E virus
24. Human Immunodeficiency Virus (HIV)
25. Tick-borne encephalitis virus
26. Rabies virus
27. Rotaviruses
28. Noroviruses
29. Astroviruses

Block 6: Mycology

Approximate characterization of the pathogen and the disease it causes:

- Classification, morphology, and staining properties
- Resistance in the environment
- Sources of infection, mechanisms, routes, and factors of transmission
- Pathogenesis of the disease, main clinical manifestations, immunity
- Laboratory diagnostics
- Principles of treatment
- Non-specific and specific prevention

1. Candida
2. Aspergillus
3. Pneumocystis
4. Cryptococcus
5. Epidermophyton
6. Trichophyton
7. Microsporum

3. Assessment Technology Description

1. This assessment methodology is developed in accordance with the USMU Regulation "On the Point-Rating System for Assessing Student Academic Achievements" dated May 5, 2025.
2. Semester attestation is based on the results of midterm assessments. The minimum total rating points a student must score in the discipline during the semester (in each semester if the discipline is studied over several semesters) to be admitted to the exam (pass/fail test) is 40 points.
3. The total rating points for the semester are calculated as the ratio of the sum of positive grades from the semester's midterm assessments to the maximum possible points based on all midterm assessments in the semester, expressed as a percentage (see formula and calculation example below):
   $R = \Sigma (a_1 + a_2 + \dots a_i) / \Sigma (m_1 + m_2 + \dots + m_i) * 100\%$, where
   - R is the final number of rating points based on the results of the current control in the semester;
   - a_1, a_2, a_i are the positive grades (3, 4, 5) received by the student based on the results of the midterm assessments provided for by the discipline's syllabus in the semester;
   - m_1, m_2, m_i are the maximum grades (5) for the same midterm assessments provided for by the discipline's syllabus in the semester.
4. Example: Out of 3 midterm assessments in the semester, a student passes 2 assessments with a grade of "3" and one assessment with a grade of "2". In this case, the sum of positive grades is 6 (3+3) divided by 15 (3 * 5, the maximum possible score for 3 assessments). The result is 0.4 or 40 points, which corresponds to the minimum passing threshold.
5. Assessment of student preparation during a midterm control is conducted in the format of a blitz survey on the module material. Students who have excelled during the module receive a grade of "5" on the midterm assessment without undergoing the blitz survey.
6. The criterion for receiving a grade of "5" on a midterm assessment without taking the blitz survey is the student having a performance rate of at least 90% during the module (see formula and calculation example below):
   $U = a * b * c * 100\%$, where
   - U is the student's performance rate based on work results during the module;

    - a is the proportion of attended (completed) classes during the module out of the total number provided by the discipline syllabus in the module;
    - b is the number of grades received during the module, divided by 1.2 times the number of classes provided by the discipline syllabus in the module (excluding the final assessment session; indicator b cannot exceed 1);
    - c is the average score of all grades received during the module, divided by 5.
7. Example 1. In a module of 5 classes (excluding the final assessment), the student attended all classes and received 6 grades (three "4"s and three "5"s). In this case, the attendance rate (a) is 1 (5/5=1), indicator b is also 1 (6 / (5 * 1.2) = 1). The average grade is 4.5 ((3*4 + 3*5)/6 = 4.5), so indicator c is 0.9 (4.5 / 5 = 0.9). The student's final performance rate for the module is 1 * 1 * 0.9 * 100% = 90%. As a result, the student receives a "5" on the midterm assessment without taking the blitz survey. Example 2. In a module of 5 classes (excluding the final assessment), the student attended 3 classes and received 3 grades (one "4", one "3", and one "2"). In this case, the attendance rate (a) is 0.6 (3/5=0.6), indicator b is 0.5 (3 / (5 * 1.2) = 0.5). The average grade is 3.0 ((4+3+2)/3=3.0), so indicator c is 0.6 (3.0 / 5 = 0.6). The student's final performance rate for the module is 0.6 * 0.5 * 0.6 * 100% = 18%. The result is below 90%; to receive a positive grade for the module, the student must take the midterm assessment in the form of a blitz survey.
8. Missed classes (no more than 40% of the total number provided by the discipline syllabus in the module) are made up on the day of the midterm assessment for the corresponding module, in the form of a blitz survey.
9. Students who have not scored 40 rating points for the semester (or for each semester, if the discipline is studied over several semesters), within the deadlines set by the department, undergo a point recovery procedure in the form of a blitz survey on the material of the failed modules.
10. Grading based on the results of the exam (pass/fail test) is done on a five-point scale and does not depend on the rating points received during the semester(s).
11. Students can receive an "excellent" grade without taking the final exam ("automatic pass") if they have an average score of at least 4.75 for all midterm assessments or if they win the intra-university Olympiad in the discipline.
12. Students who placed second and third in the intra-university Olympiad in the discipline may not answer any two questions on the exam ticket.
13. Students who reached the quarter-final stage of the intra-university Olympiad in the discipline may not answer one question on the exam ticket.

4. Criteria for Assessment during Intermediate Certification

The response criteria for the intermediate certification correspond to the response criteria for the midterm control (see section 2.3).