

MEDICAL UNIVERSITY - SOFIA
FACULTY OF DENTAL MEDICINE

EDUCATIONAL PLAN

Name of the subject: MEDICAL MICROBIOLOGY

Educational degree: Master

Type of the subject: Obligatory

Duration of the course: Two semesters (3rd & 4th), 106 academic hours

Course level: M (Master level)

Forms of assessment for the students' knowledge: Marks during the course, colloquiums during the semesters, tests, final examination

What educational forms and methods are used in the course? Lectures, seminars, practical trainings

Examination after the semester: Yes

Leading lecturers: Prof. I. Mitov, Assoc. Prof. L. Sechanova and
Assoc. Prof. L. Boyanova

**CHAIR OF MEDICAL MICROBIOLOGY AT THE MEDICAL
FACULTY – MEDICAL UNIVERSITY - SOFIA**

HIGHLIGHTS OF THE COURSE: The purpose of the course in medical microbiology for students in dental medicine is to give knowledge about microorganisms that are parasites in human organisms and cause infectious processes and the associated infectious diseases; the mechanisms of transmission; innate and acquired defensive reactions of the organism, as well as the methods for their diagnostics. The course is divided into 4 sections: **general microbiology, infection and immunity, special microbiology and clinical microbiology**. Every section pays specific attention to the processes, the normal flora and the specificities of the infections of teeth, periodontium and oral cavity.

“General Microbiology” section concerns morphology and structure of microorganisms, their physiology (multiplication, culture methods, genetic structure and function); the impact of physical and chemical factors and the associated methods and means for sterilization and disinfection; and the antimicrobial chemotherapy.

“Infection and Immunity” section deals with the interactions between the host and the pathogenic microorganisms, the specific features of the infectious diseases, microorganisms’ factors of pathogenicity and virulence, as well as the microorganisms’ defensive mechanisms in case of infections. This section provides some general knowledge about the nature of the infectious process which is necessary for the successive prophylactic and therapeutic activities. Special attention is paid to the means for specific prophylaxis and therapy of the infectious diseases (antibody containing preparations, vaccines) and the means for immunostimulation.

“Special Microbiology” section provides information about the most significant pathogenic and opportunistic microorganisms – bacteria, viruses and fungi – their morphology and biology, their resistance in the environment and to physical and chemical factors; epidemiology, clinics and pathogenesis of the infections caused by them, mechanisms of protective immunity, means for specific prophylaxis and therapy, proper chemotherapy agents, methods for microbiological diagnosis, as well as methods for prevention and control of infections.

“Clinical Microbiology” section reviews the normal microbial flora in the oral cavity and its participation in pathological processes there (caries, periodontitis, and infections developing in the mucosa and in the deep tissues). Diseases resulting from immunopathological (autoimmune and allergic) processes are also studied here. A review of the protective mechanisms in the oral cavity is included.

DESCRIPTION OF THE COURSE: The course includes 106 academic hours:
lectures – 60 academic hours
practical training – 46 academic hours

Formation of the final mark – complex; by assessing the students’ activity during the course (marks of the current checking of knowledge and tests, a colloquium in each of the two semesters, individual written works, marks from the test and the theoretical and practical examination during the session).

Considerations for the final mark: current checking of knowledge and tests, a colloquium in each of the two semesters, individual written works, final examination (a test, written and oral examination, practical examination).

ADDITIONAL EDUCATIONAL METHODS: computer PowerPoint presentations during the practical trainings; clinical cases for discussion; multimedia; overhead projectors; laboratory technical devices in the students microbiology labs.

AIM and TASKS OF THE EDUCATIONAL PLAN: To acquaint the dental medicine students with the pathogenic and opportunistic (normal flora and saprophytes) microorganisms and the infections caused by them. Special attention is paid to the infections in the oral cavity. The educational plan aims to provide the students with knowledge on the principles of infections origin and development and the host defensive reactions. The course provides knowledge about the principles, methods and measures for prophylaxis and treatment of the infectious processes and diseases: vaccines, antibody-containing preparations, immunostimulators, antibiotics and antiviral agents; methods and agents for sterilization and disinfection. A significant goal for the course is to educate on the algorithm and methods for microbiology diagnostics, incl. specimen collection and interpretation of the results.

TASKS FOR THE PRACTICAL TRAINING:

Rules towards aseptic work in the microbiology lab, medical centers and hospitals.

Rules and tools for collection, transportation and storage of specimens for microbiology testing.

Operation with immersion oil microscope.

Preparation of smears for microscoping.

Simple staining methods.

Complex staining methods.

Stages of the microbiology testing – inoculation, isolation of pure cultures, identification.

Preparation, reading, and interpretation of antibiograms.

Performing basic immunological diagnostic reactions.

Principles of preparation of disinfection solutions and rules towards the application of disinfectants and antiseptics.

Principles of sterilization – preparation of instruments, execution, methods for quality control of the sterilization. Introduction to basic devices and methods for sterilization and disinfection.

Introduction to the stages of the microbiology diagnostics for some of the major causative agents of infectious diseases.

RECOMMENDED BIBLIOGRAPHY:

Microbiology, a textbook edited by Prof. G. Mitov, 2000.

Нѳbook in microbiology – edited by G. Kaprelyan and Y. Docheva

SYNOPSIS: attached

LECTURES IN MEDICAL MICROBIOLOGY FOR STUDENTS IN DENTAL MEDICINE

Winter semester

- LECTION 1.** Subject and objectives of microbiology. Essential stages in development of microbiology. Significance of oral microbiology. Taxonomy of bacteria.
- LECTION 2.** Morphology of bacteria. Bacterial cell structure – capsule, cell wall, cell membrane.
- LECTION 3.** Bacterial cell structure – flagella, fimbriae, cytoplasm and cytoplasm structures, ribosomes, nucleoid, spores.
- LECTION 4.** Physiology of bacteria. Chemical composition of the bacterial cell. Nutrition. Enzymes. Metabolism – catabolic and anabolic reactions. Growth and reproduction, culturing of bacteria.
- LECTION 5.** Viruses – nature and properties. Bacteriophages – structure and chemical composition. Basic types of interaction between the bacterial cell and the bacteriophage. Phage infection. Temperate phages, lysogenic cycle, phage conversion. Phage typing.
- LECTION 6.** Impact of physical factors on microorganisms: temperature, dehydration, lyophilisation, osmotic pressure, UV rays, ionizing radiation, ultrasound. Impact of chemical agents on microorganisms – mechanisms of action. Disinfection, sterilization.
- LECTION 7.** Bacterial and phage genetics. Genotypes and phenotypes in bacteria and phages – the bacterial chromosome as a genetic system, extrachromosomal genetic elements (plasmids, temperate phages), transposable elements. Bacterial changeability. Mutations and mechanisms of genetic transmissions (transformation, conjugation, transduction). Genetic engineering.
- LECTION 8.** Antimicrobial chemotherapy: definition, principles of antimicrobial chemotherapy, requirements for antimicrobial agents, generic and trade names, spectrum of activity. Antibacterial chemotherapy products and mechanisms of their action.
- LECTION 9.** Antifungal chemotherapy products. Antiviral chemotherapy products. Adverse effects of antimicrobial treatment – toxic, immunologic, dysbacteriosis. Mechanisms of resistance of microorganisms to antimicrobial agents.
- LECTION 10.** Infection, infection process and infection disease. Characteristics of microorganisms' properties, factors of pathogenicity. Impact of the environment, and social factors.
- LECTION 11.** Immunity. Types. Natural resistance. Acquired immunity. Antigens. Antigenic structure of microorganisms.
- LECTION 12.** Immune system. Essential stages in immunopoiesis. Immunity response. Humoral immunity. Immunoglobulines (antibodies) – structure and biological significance. Monoclonal antibodies and their application in medicine.
- LECTION 13.** Cell-mediated immunity. Mediators of cell immunity (lymphokines and cytokines). Local (secretory) immunity and immunosecretory system. Immunity (protective mechanisms) against bacterial infections (caused by toxigenic, extracellular and intracellular bacteria), viral and fungal infections. Protective mechanisms in the oral cavity.
- LECTION 14.** Immunopathology. Innate and acquired immunity deficiency. Medicine (antibiotics, etc) and bioproducts (serums, vaccines) induced allergy.
- LECTION 15.** Immunoprophylaxis and immunotherapy of infectious diseases. Types of vaccines and serums. Immunization schedule of the Republic of Bulgaria. Immunomodulation - immunostimulation and immunostimulators, immunosuppression.

LECTURES IN MEDICAL MICROBIOLOGY

FOR STUDENTS IN DENTAL MEDICINE

Summer semester

LECTION 1. Genus *Staphylococcus*. Genus *Streptococcus* – *S. pyogenes*.

LECTION 2. Genus *Streptococcus* - *S. pneumoniae*, *S. mutans*. Family *Neisseriaceae* - meningococci. Epidemic meningitis. Gonococci – gonorrhoea. Family *Peptococcaceae* - anaerobic cocci. Diseases.

LECTION 3. Family *Enterobacteriaceae*. Genus *Escherichia*. Genera : *Klebsiella*, *Enterobacter*, *Serratia*, *Proteus*, *Morganella*, *Providencia*. Significance as opportunistic bacteria.

LECTION 4. Genus *Salmonella* – salmonellae, typhoid fever and causative agents food intoxications. Genus *Shigella* – dysentery causative agents .

LECTION 5. Genus *Yersinia*. Genus *Vibrio* – cholera causative agents. Genus *Pseudomonas*.

LECTION 6. Genus *Haemophilus*. Genus *Bordetella*. Genus *Fransisella*.

LECTION 7. Genus *Corynebacterium*. Genus *Mycobacterium*. Genus *Listeria*.

LECTION 8. Genus *Bacillus* - *B. anthracis*. Genus *Clostridium* - *C. tetani*, gas gangrene causing clostridia.

LECTION 9. Genus *Clostridium* - *C. botulinum*, *C. difficilae*. Non spore-forming obligatory anaerobic bacteria. Fusospirillary gingivitis.

LECTION 10. Family *Spirochaetaceae*. *Treponema palidum* – syphilitic lesions in the oral cavity.. Spirochetes in the oral cavity. Genus *Borrelia* - *Borrelia burgdorferi*, *Borrelia recurrentis*. Pathogenic actinomycetes , actinomyceters in the oral cavity.

LECTION 11. Family *Mycoplasmatacaeae*. Family *Rickettiaceae*. Family *Chlamydiaceae*. Pathogenic fungi. Genus *Cuida*. *Cryptococcus neoformans* .

LECTION 12. Family *Picornaviridae* – poliomyelitis virus , ECHO and coxackie viruses. Family *Ortomyxoviridae* – Genus *Influenzavirus*. Family *Paramyxoviridae* – parotitis and measles viruses. Family *Adenoviridae*. Family *Reoviridae* - rotaviruses.

LECTION 13 . Family *Rhabdoviridae* – rabies virus. Family *Herpesviridae* – common herpes, shingles, chicken pox, cytomegalovirus, infectious mononucleosis virus. Family *Togaviridae* - *Rubella virus*.

LECTION 14. Family *Hepadnaviridae* - hepatitis A, B, C, D, F. Family *Retroviridae* – HIV, AIDS causative agents.

LECTION 15. Normal microflora of the human body. Oral microflora. Microbiological aspects of pathological processes in the oral cavity: caries, infections of pulp, periapical tissues, periodontium, soft tissues.

PRACTICAL TRAINING IN MEDICAL MICROBIOLOGY

FOR STUDENTS IN DENTAL MEDICINE

Winter semester

Excercise 1 Microbiology laboratory. Bacterial morphology and structure. Microscopic methods of examination. Pfeifer and Löffler stains. Microscopic methods of examination. Gram stain.

Excercise 2 Bacterial Morphology. Microbiological methods of examination. Ziehl-Neelson, Peshkov and Neisser stains.

Excercise 3 Test examination: Morphology and structure of bacteria. Physiology of bacteria. Nutrition of bacteria. Cultivation of bacteria. Metabolism of bacteria. Bacterial enzymes. Biochemical methods of testing and examination of pure cultures.

Excercise 4 Physiology of bacteria. Growth and reproduction. Distribution of bacteria in the environment. Impact of physical and chemical agents on microorganisms.

Excercise 5 Test examination: Physiology of bacteria. Antimicrobial chemotherapy. Laboratory methods for accessing the susceptibility of bacteria to antimicrobial agents.

Excercise 6 COLLOQUIUM

Excercise 7 Infection, infection process, infectious disease. Natural resistance against infections. Immune reactions and their usage in diagnostics. Reaction of agglutination. Precipitation.

Excercise 8 Immunity. Immune reactions and their usage in diagnostics. Immune reactions with involvement of the complement, immune reactions with marked antibodies. Immunoprophylaxis and immunotherapy of infectious diseases. Vaccines, antibody-containing products, immunomodulators.

SUMMER SEMESTER

Excercise 1 Basic principles of microbiological diagnostics. Microbiological diagnosis of Staphylococcal infections.

Excercise 2 Microbiological diagnosis of Streptococcal infections. Microbiological diagnosis of diseases, caused by *Neisseria*.

Excercise 3 Test examination: cocci. Family *Enterobacteriaceae*. Microbiological diagnosis of diseases, caused by bacteria from Genera *Escherichia* and *Klebsiella*.

Excercise 4 Microbiological diagnosis of diseases caused by bacteria from Genus *Salmonella* of Family *Enterobacteriaceae*.

Excercise 5 Microbiological diagnosis of bacterial dysentery. Microbiological diagnosis of diseases, caused by bacteria from Genus *Proteus* and Genus *Yersinia*.

Excercise 6 Microbiological diagnosis of cholera. Microbiological diagnosis of diseases, caused by bacteria from Family *Pseudomonadaceae*. Microflora in the environment.

Excercise 7 Microbiological diagnosis of diphtheria. Microbiological diagnosis of pertussis and parapertussis.

Excercise 8 Microbiological diagnosis of tuberculosis. Microbiological diagnosis of actinomycosis. Microbiological diagnosis of candidiasis.

Excercise 9 Microbiological diagnosis of anthrax. Microbiological diagnosis of anaerobic infections, caused by Genus *Clostridium*.

Excercise 10 COLLOQUIUM

Excercise 11 Family *Rickettsiaceae*. Family *Chlamydiaceae*. Viruses – basic characteristics, taxonomy, principles of virology diagnostics, taxonomy, principles of virology diagnostics.

Excercise 12 Family *Picornaviridae*. Family *Reoviridae*.

Excercise 13 Family *Ortomyxoviridae*. Family *Paramyxoviridae*. Family *Togaviridae*.

Excercise 14 Family *Adenoviridae*. Family *Herpesviridae*. Family *Hepadnaviridae*. Family *Retroviridae*.

Excercise 15 Normal microbial flora of the oral cavity and its significance for development of dental diseases. Microbiological examinations in cases of dental diseases.

EXAMINATION SYNOPSIS IN MEDICAL MICROBIOLOGY
FOR STUDENTS IN DENTAL MEDICINE

I. GENERAL MICROBIOLOGY

1. Subject and goals of microbiology. Essential stages in development of microbiology. Taxonomy of bacteria.
2. Classification and nomenclature of viruses.
3. Morphology of bacteria.
4. Bacterial ultrastructure - flagella, axial filaments, pili.
5. Bacterial ultrastructure – capsule, glycocalyx.
6. Bacterial ultrastructure – cell wall in Gram-positive and Gram-negative bacteria.
7. Bacterial ultrastructure – cytoplasm, cytoplasm membrane and cytoplasm organelles.
8. Bacterial ultrastructure – nucleoid and chromosome.
9. Bacterial ultrastructure - spores.
10. Morphology and structure of fungi.
11. Physiology of microorganisms – chemical composition. Nourishment and cultivation of bacteria. Growth factors. Bacterial enzymes.
12. Physiology of microorganisms – bacterial metabolism.
13. Physiology of microorganisms - growth and reproduction of bacteria. Productivity of microorganisms.
14. Viruses – general characteristics and structure, culturing methods for viruses. Principles of virology diagnostics.
15. Impact of chemical factors on microorganisms. Disinfection, disinfectants and antiseptic agents; mechanism of action and usage.
16. Impact and mechanism of action of different physical factors on microorganisms.
17. Impact of physical factors on microorganisms – sterilization, methods of sterilization and usage.
18. Bacterial genetics. Carriers of genetic information in bacteria – Structure, replication, function.
19. Bacterial genetics. Mutations, mechanisms of recombination and DNA exchange.
20. Bacterial genetics. Genetic engineering: DNA cloning, DNA hybridization, PCR – general characteristics and use.
21. Antimicrobial chemotherapy. Principle of selective toxicity, definition of terms, requirements, names. Action of antibacterial agents.
22. Antimicrobial chemotherapy. Antibacterial agents – groups according their spectrum, activity and molecular mechanisms.
23. Antimicrobial chemotherapy. Tuberculostatics. Antimycotic and antiviral agents.
24. Antimicrobial chemotherapy. Resistance of microorganisms to antimicrobial agents – genetic and biochemical mechanisms of resistance.

II. INFECTION AND IMMUNITY

25. Infection. Interactions between microorganisms and host. Infection and infectious disease.
26. Infection. The role of microorganisms in infection. Infectivity, pathogenicity, virulence and contagiousness.
27. Infection. Pathogenicity and virulence factors of microorganisms.
28. Infection. Role of host, environment and social factors in infection. Reservoirs and sources of infections; mechanisms of transmission.

29. Infection. Pathogenesis of infection – infectious count, portals of exit and portals of entry, dissemination and localization of microorganisms in the host. Forms of infections and infectious diseases.
30. Immunity – definition, general characteristics, and types of immunity.
31. Natural resistance against infection. Physical barriers, normal human flora.
32. Natural resistance against infection. Humoral (chemical) defenses and factors. Phagocytosis and inflammation.
33. Acquired immunity. Types and forms of acquired immunity.
34. Antigens – definition and general characteristics. Antigen structure of bacteria.
35. Antibodies (immunoglobulins). Structure and biological properties of immunoglobulins.
36. Immune system – organs and cells of immune system.
37. Immune response. General characteristics. Immune response dynamics. Humoral immune response (systemic and localized). Cell-mediated immunity. The role of Major Histocompatibility Complex in immune response.
38. Protective mechanisms against bacterial, fungal and viral infections.
39. Antigen-antibody reaction – mechanism and general characteristics.
40. Agglutination.
41. Precipitation. Toxin neutralization reaction.
42. Complementary-dependent reactions.
43. Immune reactions with labeled antibodies.
44. Immunopathology. Hypersensitivity reactions (allergies).
45. Immunopathology. Autoimmune diseases. Role of hypersensitivity reactions in autoimmune diseases. Innate and acquired immunodeficiencies.
46. Immunoprophylaxis and immunotherapy. Vaccines.
47. Immunoprophylaxis and immunotherapy. Immune sera and antibody-containing preparations. Immunostimulators and immunomodulators.

III. SPECIAL MICROBIOLOGY

48. Genus *Staphylococcus*.
49. Genus *Streptococcus*. Group A streptococci (*Streptococcus pyogenes*).
50. *Streptococcus pneumoniae*.
51. Streptococci part of the normal human flora. *Streptococcus mutans* etc. Genus *Enterococcus*.
52. *Neisseria meningitidis*.
53. *Neisseria gonorrhoeae*.
54. Family *Enterobacteriaceae*. Genus *Escherichia*, *E. coli*.
55. Genus *Salmonella*.
56. Genus *Shigella*.
57. Genera *Proteus*, *Providencia*, *Morganella*; *Klebsiella*, *Enterobacter* and *Serratia* (K-E-S group).
58. Genus *Yersinia*. *Y. pestis*. *Y. enterocolitica*.
59. *Vibrio cholerae*.
60. *Haemophilus influenzae*.
61. *Bordetella pertussis*.
62. *Fransisella tularensis*.
63. Family *Legionellaceae*.
64. Genus *Pseudomonas*.
65. Genus *Corynebacterium*. *C. diphtheriae*.
66. Genus *Listeria*. *L. monocytogenes*.
67. Genus *Mycobacterium*. *M. tuberculosis*.
68. Anaerobic non-spore forming bacteria.
69. Genus *Actinomyces*.

70. Genus *Bacillus*. *B. anthracis*.
71. Genus *Clostridium*. *C. tetani*.
72. Anaerobic spore-forming clostridia causing gas gangrene.
73. Genus *Clostridium*. *Clostridium botulinum*. *Clostridium difficile* .
74. Family *Spirochaetaceae*. Genus *Treponema*. *Treponema pallidum*.
75. Genus *Borrelia*. Causative agents of Lyme disease (*Borrelia burgdorferi* etc.).
76. Genus *Leptospira*.
77. Genus *Campylobacter*. Genus *Helicobacter*.
78. Genus *Mycoplasma*. *M. pneumoniae*. *M. hominis*.
79. Genus *Chlamydia*. *C. trachomatis*. *C. psittaci*. *C. pneumoniae*.
80. Genus *Rickettsia*, Genus *Coxiella*.
81. Pathogenic fungi .
82. Picornaviruses (Family *Picornaviridae*). *Human polioviruses*. *Coxsackie-* and *ECHOviruses*.
83. Orthomyxoviruses (Family *Orthomyxoviridae*). *Influenzavirus*.
84. Paramyxoviruses (Family *Paramyxoviridae*). *Parainfluenza viruses*. Virus of parotitis (*Virus parotitidis*). Virus of measles (*Morbillivirus morbillorum*).
85. Reoviruses (Family *Reoviridae*). Rotaviruses (Genus *Rotavirus*).
86. *Rubella virus*.
87. Rhabdoviruses (Family *Rhabdoviridae*). *Rabies virus*.
88. Retroviruses (Family *Retroviridae*). HIV-1 and HIV-2.
89. Herpesviruses (Family *Herpesviridae*). *Human herpesvirus 1, 2*; (*Virus herpes simplex*). *Varicella-zoster (Human herpesvirus 3, Herpesvirus varicellae)*.
90. Hepatitis viruses (*Human hepatitis A, B, C, D, E and G viruses*).
91. Prions.
92. Microorganisms in the environment.
93. Microbial flora of human body in health and disease.
94. Microbial flora in the oral cavity.
95. Etiological factors and pathogenesis mechanisms in pathological processes in oral cavity and teeth.
96. Pathological processes in the oral cavity caused by microorganisms. Caries.
97. Pathological processes in the oral cavity caused by microorganisms. Diseases of dental pulp and periapical tissues.
98. Pathological processes in the oral cavity caused by microorganisms. Periodontal diseases.
99. Pathological processes in the oral cavity caused by microorganisms. Infections of устната лигавица and дълбоките тъкани.
100. Pathological processes in the oral cavity caused by microorganisms. Focal infection. Hypersensitivity and its clinical significance in dental medicine.
101. Protective mechanisms in the oral cavity. Specificities of the natural resistance and acquired immunity in the oral cavity.

PRACTICAL EXAMINATION

1. Gram stain - preparation, observation and interpretation.
2. Smear preparation and staining by Ziehl – Neelsen method. Technique, observation and examination of the preparations.
3. Neisser stain – preparation, observation and interpretation.
4. Smear preparation and staining by Peshkov method. Technique, observation and examination of the preparations.
5. Simple nutrient media. Types, composition and application. Observation (characteristic) of bacterial growth in broth and agar media.
6. Special (enriched) nutrient media. Types, composition and application. Observation (characteristic) of bacterial growth in broth and agar media.
7. Elective, selective and differentiation nutrient media. Types, composition and application. Observation (characteristic) of bacterial growth in broth and agar media.
8. Methods and nutrient media for cultivation of aerobic bacteria. Preparation of pure culture.
9. Methods and nutrient media for cultivation of anaerobe and microaerophile bacteria. Reading of the growth of anaerobe bacteria.
10. Biochemical tests for the identification of bacteria. Tests for determination of carbolytic, proteolytic enzymes and oxidoreductases. Kligler's polytrophe medium (Triple Sugar Iron Agar): composition, inoculation and reading.
11. Quantitative methods for the determination of bacterial growth: enumeration with optical standard and determination of microbial count on a solid medium.
12. Antibiotics and chemotherapeutics – characteristics and usage.
13. Serial Dilution Method for Antimicrobial Susceptibility Testing.
14. Disk Diffusion Method for Antimicrobial Susceptibility Testing (NCCLS method).
15. Methods of sterilization. Use of the particular methods in medical practice.
16. Disinfectants. Use of the particular disinfectants in medical practice.
17. Slide agglutination (direct agglutination): principle, technique and reading of the results.
18. Widal's serodiagnosis (tube agglutination method). Principle, technique and reading of the results.
19. Passive hemagglutination, coagglutination, latex agglutination. Principle, technique and reading of the results.
20. Ring precipitation test (thermoprecipitation). Principle, technique and reading of the results.
21. Ouchterlony double immunodiffusion (DID). Radial single immunodiffusion. Immunoelectrophoresis. Principle, application, reading of the results.
22. Titration of hemolytic serum – application, principle, technique and reading of the results.
23. Complement fixation reaction for diagnosis of syphilis: Wassermann's reaction. Application, principle, reading of the results.
24. ELISA (Enzyme-linked immunosorbent assay) – basic principle, reading and interpretation of results, application. Immunofluorescence – direct and indirect immunofluorescence, application.
25. Virus hemagglutination and hemagglutination inhibition (HAI) reactions - application, principle, technique and reading of the results.
26. Neutralization test of viral infectivity - basic principle, reading and interpretation of results, application.
27. Antibacterial vaccines - characterization, application.
28. Antiviral vaccines – characterization, application.
29. Immune sera - characterization, application. Immunoglobulin preparations. Immunomodulators.
30. Microbiological testing of microbial flora – specimens collection and transportation, stages of the examination, reading the results.

31. Tests for detection and pathogenicity of *Staphylococcus* spp. – reading and interpretation of results.
32. Tests for identification of *Streptococcus* spp. and *Enterococcus* spp.
33. Biochemical identification of the organisms of Family *Enterobacteriaceae*. Tests for identification.
34. Sanitary-microbiological examination of potable water, soil, air, and food.
35. Specimen collection from teeth and oral cavity for microbiological examination. Principle of the examination and reading the results.