MEDICAL UNIVERSITY OF PLOVDIV

FACULTY OF MEDICINE

Department of Medical microbiology and immunology „Prof. Dr. Elissay Yanev”

ACADEMIC STANDARD

OF

MICROBIOLOGY

FOR

MEDICAL STUDENTS

MEDICAL UNIVERSITY – PLOVDIV

FACULTY OF MEDICINE

Department of Medical microbiology and immunology

„Prof. Dr. Elissay Yanev"

1. Purpose of Microbiology course

The main objective of the course in Microbiology for medical students is to obtain a thorough knowledge of the morphological and biological characteristics of microorganisms, the patterns of development of the infectious process, the specific and non-specific immune protection of the organism, the diagnosis of infectious diseases and the prevention and control of infections.

The objective is consistent with:

• the volume and credit rating of the discipline (ECTS system), evident from the syllabus available on the website of MU - Plovdiv;

• the qualification characteristics of the specialty;

• educational degree (Master);

The objective is consistent with the position of Microbiology discipline in the specialty Medicine in its importance and chronology in the curriculum. As a fundamental discipline, it predominantly serves the next stages of training.

Priority goals of the University are: Development of students' personal qualities, encouragement of their initiative, creation of habits of permanent self-education and ability to learn on their own, acquisition of "transferable" knowledge, key competences and skills.

This is introduced in the content of the course in Microbiology.

2. Course content of the course Microbiology

The topics and hours of lectures and practical classes in microbiology are listed on the website of MU - Plovdiv:

https://mu-plovdiv.bg/en/faculties/faculty-of-medicine/departments/department-of-microbiology-and-immunology/ and in Annex 1.

The content is arranged chronologically so that each subsequent lecture and related practicals use already learned material and concepts. The unnecessary overlap or the existence of "white spots" between "curriculum-related" disciplines is avoided.

The main objectives of the microbiology curriculum are:

• Introduction to the morphology, physiology and pathogenic factors of microorganisms that play a role in human pathology;

• Studying the patterns of emergence and course of the infectious process, the pathogenesis of infectious diseases and the various forms of infection;

• Studying the mechanisms for protection of macroorganisms - natural resistance and adaptive immunity, as well as the principles of immunoprophylaxis and immunotherapy of infectious diseases;

• Antimicrobial chemotherapy – knowledge about the mechanisms of action of main groups and representatives antimicrobial agents, as well as the mechanisms for the development of bacterial resistance;

• The principles and basic methods of sterilization and disinfection;

• Mastering the microbiological diagnostics of infectious diseases; the structure and role of the microbiological laboratory for the etiological diagnosis of infectious diseases; skills for proper clinical interpretation and analysis of laboratory results;

• Studying the methods for microbiological, immunological and molecular biological diagnostics of infectious diseases, as well as the correct interpretation of the obtained results;

• Studying the composition and role of the normal microflora of the human body;

• Exploring the role of the external environment in the spread of infectious agents and the methods and means of microbiological control of the environment.

3. Prerequisites

The medical student must have a basic knowledge of biology and chemistry from first-year medical university degree programs in order to begin and successfully complete their microbiology training.

4. Academic resources

The academic staff of the Department of Microbiology and Immunology includes 6 habilitated lecturers, one of whom is employed on a civil contract, and 2 non-habilitated lecturers holding a PhD degree in the respective scientific specialty—one in microbiology and one in immunology. The total number of non-habilitated lecturers is 12.

Among all teaching staff, 10 hold a specialty in microbiology, 2 in immunology, and 1 also has a specialty in virology. Two lecturers are assigned to and conduct training in microbiology, while four are involved in training in immunology.

Three of the habilitated lecturers on full employment contracts and one on a civil contract also hold a second Master's degree in "Health Management."

The lectures are led by a habilitated lecturer (professor or associate professor) with an educational and scientific degree „Ph.D" under the relevant doctoral program. Up to 30% of the lectures are assigned to non-habilitated teachers who hold a Ph.D.

Practical classes are conducted by habilitated and non-habilitated teachers (assistant or chief assistant). Non-habilitated teachers hold a Master's Degree in Medicine and are elected by a competition.

5. Material resources

The Department of Microbiology and Immunology of MU-Plovdiv has 4 teaching laboratories, equipped with microscopes with specialized observation software, multimedia presentation equipment and an interactive training system for students to illustrate the learning process. The total (laboratory) area of the department is 470.27 m^2. Of these, the laboratory premises are 141m^2. The department also has a collection of laboratory equipment and microscopes to assist with the study work as demonstration materials. The laboratory equipment of the department includes general

equipment (laboratory scales, refrigerators, freezers, including low-temperature at 80 C°, standard incubators, CO^2 incubator, water baths, centrifuges (including high-speed), and specialized diagnostic equipment: nephelometer, immunofluorescent and inverted microscopes, two PCR apparatus, real-time PCR, multiplex PCR for specialized diagnosis and research in meningitis, intestinal, respiratory infections and sepsis, ELISA apparatus, automated immunoblot, automated bacterial growth analyzer for body fluids, automatic fluorimeter for viral marker detection, MALDI-TOF system for microbial identification, museum exhibition of antique microbiological devices.

6. Lecture training

The lectures are prepared and delivered in the form of multimedia presentations, which are provided to students electronically, including on the site of MU – Plovdiv, so that they can prepare for each class. The volume and format of the lectures are the choice of the leading speaker.

7. Laboratory practicals

They are conducted in groups. Methodical instructions, manuals and tests are provided for the practicals.

Tests check:

- student training;

- the results (knowledge and skills gained) of the specific practical.

There is a discussion with the students.

8. Information resources. Basic literature. Sites.

The lecturers are obliged to prepare lectures and practicals in the discipline and to provide their lectures, training tests and other teaching materials in electronic form.

A list of the main recommended literature for the discipline of microbiology for each of its components (lectures, practicals) with priority of the available sources (main literature) are provided. Internet resources may also be recommended to find suitable materials.

Student books:

1. Medical Microbiology Textbook for students of medicine, dentistry and pharmacy. Third major revised and expanded edition. Edided by Ivan Mitov, ARSO – Sofia, 2024, ISBN: 987-619-197-088-9.
2. Murray P, K. Rosenthal, M. Pfaller, Medical Microbiology, 10th edition, 2025, ELSEVIER, ISBN: 9780443261336.
3. Levinson W, Review of Medical Microbiology and Immunology, 17th edt, 2022, McGraw-Hill Education, ISBN: 978-1264267088.
4. Samaranayake L, Essential of Microbiology for Dentistry, 6th edition, 2024, Elsevier, ISBN: 978-0443118210

Manuals

1. *Manual for Practical Exercises in Medical Microbiology – Part I*, edited by Ivan Mitov and Rayna Gergova, 2nd edition, year of publication: 2025, Medical Publishing House “Arso”

2. *Manual for Practical Exercises in Medical Microbiology – Part II*, edited by Rayna Gergova, year of publication: 2025, Medical Publishing House "Arso"

Web sites:

1. https://www.ncbi.nlm.nih.gov/books/NBK7627/

2. http://www.textbookofbacteriology.net/

3. The site of the Department of Microbiology and Immunology is on the web site of MU-Plovdiv:

http://mu-plovdiv.bg/en/faculties/faculty-of-pharmacy/departments/department-of-microbiology-and-immunology/

where microscopic slides, nutrient media, some practical microbiology tests and lecture courses are available.

9. Control works

Students are loaded down with the study material dynamically and intensively throughout the semester. The presumption is that the method of acquiring knowledge and skills is an important factor for their depth, durability and applicability. Teachers monitor students' progress at least twice a semester. Ongoing control is performed through tests or control assignments. Students are provided with timely information and explanations of the results of the tests to assist in their further training. Up to 5 (five) days after the announcement of the results the student has the right to get acquainted with his work.

The results of these examinations are included as a component in the final semester grade.

10. Independent training and extracurricular work of the student

The independent work is guided by the teacher (assistant), who guides the student both in the literary sources and in the methods of their mastering. Sample training tests are provided, including online, for self-study and student exercises. The electronic version of microscopic slides, nutrient media and some practical microbiology tests available on the Department's website at MU-Plovdiv website are also helpful in this regard.

11. Collaboration between teachers and students

This cooperation shall be expressed in:

- teacher's commitment to the student and his / her preliminary training, current difficulties in mastering the material and opportunities for individual learning program to achieve better results.

- consultation hours according to a pre-approved schedule announced in the department.

- to involve students in teams of scientific assignments, research, projects, circular activities, etc.

12. Exams

1. The on-going assessments planned in the specialty curriculum shall be given for:

- The student's results in laboratory and/or seminar practicals, individual tasks, student's work with the research and project teacher, etc.;

- At least two (one in the middle and one at the end of the semester) control writing exams or student work.

2. The semester exam consists of:

- A comprehensive test conducted on the “Forms” platform of MS Office 365 in a controlled electronic environment.

The final grade is determined by a committee consisting of the examiner and two assistants. The primary factor in determining the grade is the comprehensive test conducted on the “Forms” platform; however, the student’s consistency, as reflected in their ongoing assessment during the semester, is also taken into account.

13. Evaluation standards:

The standards for evaluating student medical achievement are carefully considered and defined so as to objectify students' evaluations, which are not crucial to the subject of the teacher.

Description of the standards for the assessment of the microbiology exam:

- Excellent (6) - for a good knowledge of information sources, thoroughly mastered essential and additional knowledge and skills, a meaningful and correct understanding of the matter, skills to solve complex cases, own thinking and reasoning of decisions;

- Very good (5) - for very well mastered essential and additional knowledge, a meaningful and correct understanding of the material, skills for applying the learned material in complex case studies;

- Good (4) - for mastering essential and additional knowledge to solve cases and tasks, but without being able to develop them into independent thinking;

- Average (3) - for mastering essential knowledge and solutions to simple tasks related to microbiological diagnostics;

- Poor (2) - Does not meet any of the requirements above;

As they begin their microbiology classes, students are introduced to the assessment norms, the procedures for on-going monitoring and the opportunities to receive feedback on their progress during the semester.

14. Formation of the final assessment

The final grade determines the extent to which a student has achieved the learning objectives set at the beginning. It is composed of two components and includes a grade from a final exam conducted in an electronic environment, as well as grade(s) from continuous assessment (colloquia, tests).

Other possible components include:

- grades from laboratory and/or seminar exercises during the semester;
- grades from work with the course instructor on research and projects.

For each component included in the final grade, a weighting coefficient (from 0 to 1) is assigned, with the total sum of all coefficients always equal to 1. The final grade is calculated as the weighted sum of the grades (on a six-point grading scale) from the different components.

Final grade (Q) = K_1 × (continuous assessment grade) + K_2 × (final exam grade)
$K_1 = 0.20$; $K_2 = 0.80$
If one of the components of the final grade is poor 2, then the final grade is poor 2.

The components involved in forming the grade and the coefficients of significance for each discipline are determined by the Academic Council with the adoption of this Academic Norm of the discipline.

In the semester exam students' written papers are evaluated anonymously.

The examination materials in Microbiology are stored and the students are given the opportunity to get acquainted with them and the grounds for assessment according to the procedure announced in advance. Students have access to the exam materials and results no longer than 5 working days after the exam date.

The students are informed for the characteristics of the discipline Microbiology at the beginning of the training.

This requirement is set in accordance with the higher education law, line 56, paragraph 1, "Teachers are obliged to develop and publicize, in an appropriate manner, a description of the lecture course they provide, including the titles and sequences of the topics of the course content, reference literature, the method of forming the assessment and the form of assessment of knowledge and skills."

15. Documentation, storage of results and control of evaluation activities

• assessed students have the right and obligation to be informed of the regulations, procedures and results of assessment, to make claims and complaints in the event of non-compliance with these rules.

• the student's right within the meaning of the preceding paragraph is valid in the case of identified technical defects or errors (e.g. in calculating or drawing up the grades), as well as on serious grounds for discrepancy between the actual knowledge, skills and competences shown and the final evaluation obtained for them.

• adjustments to the grades in the preceding of the above mentioned paragraph in the student record book, exam protocol or in the general grade book are allowed only by the discipline holder.

• any disputes and claims by the students should be made in written form to the assessment team, who should provide a motivated answer by the end of the next working day.

• established and proven cases of a serious violation of the student's rights in the assessment of his / her knowledge, skills and competences are addressed by a written complaint to the Vice Rector for quality.

The academic standard for the discipline has been approved by decision of the Academic Council - Protocol №4/14.04.2026 and published on the website of the MU - Plovdiv.

Approved:
Head of Dept. Medical microbiology and
immunology „Prof. Dr. Elissay Yanev“
/Prof. Dr. M. Petrov, MD, PhD, MHM/

MEDICAL UNIVERSITY – PLOVDIV

FACULTY OF MEDICINE

Department of Medical microbiology and immunology

„Prof. Dr. Elissay Yanev”

SYLLABUS

IN

MICROBIOLOGY

Approved by the Department Council - Protocol №4/14.04.2026

Confirmed by the Faculty Council - Protocol №../…….

MICROBIOLOGY

Syllabus

Discipline	Final exam/ semester	Academic hours				Extracurricular load/activity	Total credits	Academic hours in years and semesters	
								II/III year	
		Total	Lectures	Practices	ECTS			IV	V
Microbiology	V	135	60	75	9.3	3.5	8.0	2/3	2/2

DISCIPLINE:
Microbiology

TYPE DISCIPLINE ACCORDING TO THE UNIFORM STATE REQUIREMENTS: Mandatory

LEVEL OF EDUCATION:
Master's Degree /**M/**

FORMS OF TRAINING: Full-time study

YEAR OF TRAINING: 2nd and 3rd year

DURATION OF TRAINING: 1 year (2 semesters)

ACADEMIC HOURS:
60 hours of lectures, 75 hours of practical classes

TECHNICAL EQUIPMENT APPLIED IN THE TRAINING:

- multimedia presentations
- video demonstrations
- links and references to internet resources and current scientific articles
- demonstration materials
- lectures
- teaching aids
- discussions
- electronic platforms (MS Office 365, Zoom, etc.)

Methods for stimulating students' creative activity:

- participation in discussions
- development of presentations and student projects
- work with online platforms
- solving cases, analysis of laboratory results

Assessment forms: include the following components:

- a comprehensive combined test covering all sections of the taught material
- ongoing assessment throughout both semesters

Formation of the grade:
The final grade for the discipline is formed by the following components:

- grade from a complex test in a controlled electronic environment
- average grade from the current control (colloquiums, tests) for the two semesters.

Aspects in forming the score:

For each component participating in the final score, a significance coefficient (from 0 to 1) is determined, and the total sum of the coefficients must always be 1. The final score is obtained as the sum of the six-point scores from the different components, multiplied by the corresponding significance coefficients.

Q final grade = **K1 Q** average grade from current control **+ K2 Q** grade from the comprehensive test
K1 = 0.20; K2 = 0.80

Semester Exam: Ye*s*

State Exam: No

LECTURER:
Habilitated lecturer from the Department of Medical Microbiology and Immunology
Assoc Prof. Michael Petrov, MD, PhD, MHM

DEPARTMENT: Medical microbiology and Immunology "Prof. Dr. Elissay Yanev"

ANNOTATION
The main goal of the Microbiology course is to thoroughly introduce medical students to the morphological and biological characteristics of microorganisms, the patterns of the development of the infectious process, the specific and nonspecific immune defence of the body, the diagnosis of infectious diseases, the main point and problems of antimicrobial chemotherapy, specific prevention and control of infection.

The goal is in accordance with:
• the scope and credits of the course (according to the ECTS system), as noted in the curriculum, available on the website of MU – Plovdiv;
• the qualification characteristics of the specialty;
• the educational degree (master's degree).

The goal conforms with the place of the microbiology discipline in the specialty of Medicine in its importance and chronology in the curriculum. As a fundamental discipline, it predominantly serves the next stages of training.

BASIC AIMS OF THE DISCIPLINE

- Introduction to the morphology, physiology, and pathogenicity factors of microorganisms that play a role in human pathology;
- Studying the patterns of occurrence and course of the infectious process, the pathogenesis of infectious diseases and various forms of infection;

- Studying the mechanisms for the protection of macroorganisms - natural resistance and acquired immunity, as well as the principles of immunoprophylaxis and immunotherapy of infectious diseases;
- Antimicrobial chemotherapy - mastering the mechanisms of action of the main groups and types of antimicrobial agents, as well as the mechanisms for the development of bacterial resistance;
- Principles and basic methods for sterilization and disinfection;
- Mastering the microbiological diagnostics of infectious diseases; the structure and role of the microbiological laboratory for the etiological diagnosis of infectious diseases; skills for correct clinical interpretation and analysis of laboratory results;
- Learning the methods for microbiological, immunological, and molecular-biological diagnostics of the infectious diseases, as well as the correct interpretation of the obtained results;
- Studying the composition and role of the normal microflora of the human body;
- Studying the external environment's role in the spread of infectious agents and methods and means for microbiological control of the environment.

➢ EXPECTED RESULTS

After the microbiology course, medical students should be familiar with the morphological and biological characteristics of the most important microorganisms for human pathology, their pathogenic factors, patterns for the development of the infectious process, and the forms of specific and nonspecific immune defence against a given microorganism. They must have mastered the rules for collecting and sending pathological material for microbiological examination, the methods for microbiological examination, the interpretation of the obtained results depending on the clinical syndrome, as well as the diagnosis, prevention, and control of the infection.

LECTURES

LECTURE PROGRAM
II year, IV semester

№	TOPIC	HOURS	DATE
1.	Subject, tasks, historical development, and achievements of microbiology. Introduction to general microbiology.	2	
2.	Morphology and structure of microorganisms.	2	
3.	Physiology of bacteria. Bacterial genetics – I part.	2	
4.	Genetics of microorganisms – 2 part.	2	
5.	Influence of environmental factors on microorganisms. Disinfection and sterilization.	2	
6.	Antimicrobial therapy of infectious diseases. Classes and groups of antibiotics. Antimicrobial resistance.	2	
7.	The study of infection. Characteristics and forms of the infectious process. The role of the microorganism in the infectious process. Pathogenic factors.	2	
8.	The role of the external environment in the occurrence of the infectious process. Epidemic process. Factors and mechanisms for the transmission of infectious agents in the epidemic process.	2	
9.	Immunity. Natural resistance. Protective role of skin, mucous membranes, normal microflora. Cellular and humoral factors of natural resistance. Phagocytosis. Inflammation.	2	
10.	Antigens and antibodies.	2	
11.	Specific humoral immunity. Specific cellular immunity. Immunological tolerance.	2	
12.	Immunopathology. Allergies - definition and forms.	2	

13.	Immunopathology. Immunodeficiency conditions and diseases. Autoimmunity.	2	
14.	Immunoprophylaxis and immunotherapy.	2	
15.	Scheme and course of microbiological research.	2	

HOURS: 30

LECTURE PROGRAM
III year, V semester

№	TOPIC	HOURS	DATE
1.	Cocci - staphylococci, streptococci.	2	
2.	Streptococcus pneumoniae. Mycobacterium *tuberculosis*. The causative agent of leprosy. Causative agents of mycobacteriosis.	2	
3.	Corynebacteria. Pertussis bacteria. Hemophilus spp.. Neisseria spp.	2	
4.	Anaerobes. Spore-forming - tetanus bacillus, gas gangrene bacilli, botulinum bacillus. Non-spore-forming anaerobes.	2	
5.	Causes of particularly dangerous infections. The causative agent of plague. Vibrio cholerae. Bacillus anthracis.	2	
6.	Causes of particularly dangerous infections. Brucella spp. Tularaemia bacterium. Legionellosis. Facultative pathogenic intestinal bacteria - Escherichia coli, Klebsiella spp., Proteus spp., and others.	2	
7.	Pathogenic enteric bacteria: Dysenteric bacteria. Salmonella - Salmonella typhi, Salmonella paratyphi A and B, Salmonella spp., causes of food poisoning.	2	
8.	Spirochetes. Cause of syphilis. Cause of typhus. Cause of Lyme disease. Leptospira. Spirilla.		
9.	Mycoplasma spp. and Rickettsia spp. Chlamydia spp.	2	
10.	Pathogenic fungi – Candida spp., actinomycetes, Aspergillus spp., cryptococci.	2	
11.	Viruses - nature and properties. Picornaviruses.	2	

12.	Orthomyxoviruses. Paramyxoviruses. Cause of COVID-19 (SARS-2)	2	
13.	Adenoviruses. Togaviruses. Flaviviruses. Rhabdoviruses. Ebola and Zika viruses.	2	
14.	Hepatitis viruses. AIDS viruses.	2	
15.	Herpesviruses. Poxviruses.	2	

HOURS: 30

PRACTICES

PROGRAM FOR PRACTICAL CLASSES
II year, IV semester

№	TOPIC	HOURS	DATE
1.	Structure and equipment of the microbiological laboratory and rules for work in it. Methods for studying the morphology of microorganisms. Types of microscopes. Immersion system microscopy. Study of the morphology of microorganisms in a coloured state. Simple staining methods - Löffler and Pfeiffer stain.	3	
2.	Complex methods for staining the microorganisms. Gram and Neisser stain. Ziehl-Neelsen staining (acid-fast bacteria). Möller staining (spores).	3	
3.	Cultivation of microorganisms. Types of nutrient media. Methods for isolation of microorganisms in pure culture. Types of cultures and colonies.	3	
4.	Biochemical activity of bacteria. Pathogenic factors in bacteria.	3	
5.	Determination of the in vitro susceptibility of bacteria to antibiotics (antibiogram). Other methods for detection of antimicrobial resistance.	3	
6.	Resistance of microorganisms. Sterilization and sterilization methods. Disinfection and disinfectants.	3	
7.	Recapitulation of the studied material in practical classes from №1 to №6 included.	3	

8.	SEMINAR on the topic: Morphology, physiology, and genetics of microorganisms. Test №1.	3	
9.	Cellular and humoral basis of the immune response. Antigen-antibody reactions. Agglutination reaction. Precipitation reaction. Neutralization reaction (ASO).	3	
10.	Antigen-antibody reactions. Bacteriolysis, hemolysis, cytolysis. Complement fixation test. Immune reactions with labeled antibodies or antigens: immunofluorescence assay (IFA), radioimmunoassay (RIA), enzyme-linked immunosorbent assay (ELISA).	3	
11.	Flowcytometry to determine cell subpopulations (immunophenotyping). Examination of the allergic condition. Bioproducts - vaccines and sera.	3	
12.	SEMINAR on the topic: Infection and Immunity. Test №2	3	
13.	Laboratory diagnosis of diseases caused by viruses and rickettsiae. Chlamydia?	3	
14.	Methods for microbiological diagnosis of infectious diseases. General scheme for microbiological research.	3	
15.	Assessment of the practical skills of students, acquired during the semester.	3	

HOURS: 45

PROGRAM FOR PRACTICAL CLASSES
III year, V semester

№	TOPIC	HOURS	DATE
1.	Microbiological diagnosis of staphylococcal and streptococcal infections. Microbiological examination of pus.	2	
2.	Microbiological examination in diseases caused by *Streptococcus pneumoniae.* Microbiological diagnosis of tuberculosis and leprosy. Microbiological examination of sputum.	2	
3.	Microbiological diagnosis of diphtheria and pertussis. Microbiological examination of throat swabs.	2	
4.	Microbiological diagnosis of gas gangrene and tetanus. Microbiological examination of wound secretions.	2	

5.	Microbiological examination of CNS materials. Microbiological diagnosis and differential diagnosis of bacterial meningitis *(Neisseria meningitidis* and *Haemophilus influenzae*).	2	
6.	Microbiological diagnosis of particularly dangerous infections plague, cholera, and anthrax.	2	
7.	SEMINAR on the topic: Microbiological diagnostics of microorganisms, studied in practical classes from №1 to №7. MCQ №1.	2	
8.	Microbiological examination of materials from the digestive system (feces). Microbiological diagnosis of bacterial dysentery, *E. coli* enteritis, salmonellosis. Food poisoning by *Staphylococcus aureus*, clostridia (*C. botulinum*, *C. perfringens*). Microbiological examination of gastric mucosa biopsy material (*Helicobacter pylori*).	2	
9.	Microbiological examination of urine. Microbiological diagnosis of pathogens causing urinary tract infections: opportunistic pathogens (*E. coli, Klebsiella, Proteus-Providencia-Morganella* group, *Pseudomonas spp*.) and obligatory pathogenic (streptococci, salmonella, *Leptospira spp., Mycobacterium tuberculosis*).	2	
10.	Microbiological examination for sexually transmitted infections caused by Neisseria gonorrhoeae, *Treponema pallidum, Candida albicans, Chlamydia spp.,* and mycoplasmas.	2	
11.	Microbiological examination of blood - blood culture. Causes of septic conditions: obligatory pathogenic (*Salmonella typhi, Brucella spp., Borrelia spp.)* and facultative pathogenic.	2	
12.	Problematic microorganisms causing healthcare-associated infections (HAIs) - *Pseudomonas spp., Enterococcus spp.,* MRSA*, C. difficile*). Systemic mycoses, caused *by Candida, Aspergillus, Actinomyces, Cryptococcus.* Antimitotic therapy.	2	
13.	Microbiological diagnosis of diseases caused by viruses – HIV and hepatitis A, B, C D and E, influenza and coronaviruses – SARS-CoV-2.	2	
14.	Sanitary-microbiological examination of water, air, hospital environment. Sanitary-indicative microorganisms - *E. coli, Enterococcus spp., C. perfringens*, staphylococci, streptococci. MCQ 2 (includes practicals 8-13)	2	
15.	Recapitulation of the students' practical skills, acquired during the two semesters with an evaluation mark.	2	

HOURS: 30

LECTURES

LECTURE №1 – 2 hours

Subject, tasks, historical development, and achievements of microbiology. Introduction to general microbiology.

Introduction. Subject, tasks, historical development, and achievements of microbiology. The contribution of L. Pasteur and R. Koch. General Microbiology. Taxonomy of microorganisms. Characteristics of major groups of microorganisms: higher protists (Eucaryote) and lower prostists (Procaryotae).

LECTURE №2 – 2 hours

Morphology and structure of microorganisms.

Morphology of microorganisms – size, shape and arrangement. Major types according to the morphology – rod-shaped, round-shaped and curved bacteria; structure of the bacterial cell, essential and non-essential organelles. Methods of studying the morphology of bacteria, fungi, mycoplasmas, and viruses.

LECTURE №3 – 2 hours

Bacterial physiology

Chemical composition of bacteria – water, minerals, proteins, carbohydrates, lipids, and nucleic acids. The significance of bacteria for diagnosis, pathogenesis, and therapy of infectious diseases. Bacterial enzymes. Bacterial metabolism – catabolic (dissimilation). Types of bacteria according to the mechanism of biological oxidation. Anabolic processes (assimilation). Bacterial productivity and its significance in infectious diseases pathogenesis, diagnosis, and therapy. Bacterial growth and reproduction. Principles of in vitro culturing and nutritional requirements of bacteria. Prototrophs and auxotrophs.

LECTURE №4 – 2 hours

Bacterial genetics

Genotype and phenotype in bacteria, viruses and phages. Bacterial genome – chemical composition, structure, and functions. Plasmids (extrachromosomal elements). Types of plasmids and their significance. Bacteriophages and their importance – structure, temperate phages, lytic phages. Inheritance and mutation in microorganisms – definitions. Types of mutations; factors causing mutations. Recombination – significance for biological and medical practice. Gene engineering – significance for the medical theory and practice. Molecular methods (PCR, DNA probes) in the diagnosis of infectious diseases.

LECTURE №5 – 2 hours

Influence of environmental factors on microorganisms. Disinfection and sterilization.

Microbiota of the human body – role in the normal physiological processes, protection, and pathology. Distribution of microorganisms in soil, water, food, hospital environment, instruments, and the objects in the surrounding environment. Influence of physical factors on microorganisms – heat, desiccation, pH, osmotic pressure, light, ultrasound, ionizing radiation. Sterilization. Methods

of sterilization. Influence of chemical factors on microorganisms. Oligodynamia. Disinfections. Types of disinfectants. Mechanism of action. Influence of biological factors on microorganisms – symbiosis, synergy, antagonism, bacteriocins, bacteriophages.

LECTURE №6– 2 hours

Antimicrobial therapy of infectious diseases. Classes and groups of antibiotics. Antimicrobial resistance.

Chemotherapy. Antibiotics. Types of antimicrobial drugs. Classification of antibiotics according to: origin, spectrum of action, chemical composition. Antibiotic drugs by groups according to chemical composition and mechanism of action. Basic principles of chemotherapeutic and antibiotic drug application. Mechanism of resistance in microorganisms. Measures against drug resistance. Side effect of antibiotic treatment. Antimicrobial susceptibility testing to antibiotics. Antibiograms. Other methods for in vitro antimicrobial susceptibility testing in microorganisms.

LECTURE №7 – 2 hours

The study of infection. Characteristics and forms of the infectious process. The role of the microorganism in the infectious process. Pathogenic factors.

Relationships between micro- and macroorganism - mutualism, commensalism, parasitism, saprophytism. Infection, infectious process, infectious disease – definition. Role of the microorganism in infectious process: pathogenicity, virulence, infectious dose, contagiosity, invasiveness, toxigenicity. Virulence factors: adhesion factors, factors of invasion, factors of aggression – endotoxins, exotoxins, etc. Mechanism of action.

LECTURE №8 – 2 hours

The role of the external environment in the occurrence of the infectious process. Epidemic process. Factors and mechanisms for the transmission of infectious agents in the epidemic process.

Pathogenesis of the infectious process – entry, dissemination, localization, and damage to the host. Characteristics of the infectious disease. Types of infectious process: exogenic and endogenic infection. Primary infection, re-infection, secondary infection; superinfection, co-infection; localized and systemic infection; focal infection; septicaemia, bacteraemia, viremia, toxaemia, pyemia, systemic inflammatory response syndrome (SIRS). Role of the host in the infectious process. Role of the environment for the origination and course of the infectious process. Epidemic process – factors and mechanisms. Factors for origination of the epidemic process: source of infection, mechanism of transmission, and susceptible population. Primary and secondary forces of the epidemic process.

LECTURE №9 – 2 hours

Immunity. Natural resistance. Protective role of skin, mucous membranes, normal microflora. Cellular and humoral factors of natural resistance. Phagocytosis. Inflammation.

Types of protection of the host – natural resistance, acquired immunity. Protective role of skin and mucous membranes, their secretions, resident microbiota. Cellular factors of the innate immunity – macrophages, microphages, NK cells. Phagocytosis. Humoral factors of the innate immunity: complement system, interferons, lysozyme, cytokines, acute phase proteins. Inflammations – protective and pathologic mechanisms.

LECTURE №10 – 2 hours

Antigens and antibodies.

Antigens – characteristics; antigen determinants (epitopes), antigen valence, haptens; types of antigens; microbial antigens. Structure of antibodies. Classes of antibodies and their function.

LECTURE №11 – 2 hours

Specific humoral immunity. Specific cellular immunity. Immunological tolerance.

Immune system: anatomy and structure. Central and peripheral organs of the immune system. Formation of immunocompetent cells – T-cells and B-cells and their subpopulations. CD-molecules, defining lymphocyte subpopulations and the significance of the immune reaction. T-cell receptor and B-cell receptor for antigens. Cell-mediated immunity – types. Humoral immunity. Antigen presentation. Development of the immune response; cell-to-cell cooperation. Primary and secondary immune response. Genetic control and regulation of immune response. HLA system. Immune tolerance – mechanisms.

LECTURE №12 – 2 hours

Immunopathology. Allergies - definition and forms.

Allergic reactions. Type of allergens. Types of hypersensitivity reactions according to the Cooms and Gell classification: Type I anaphylactic and atopic allergic reactions with participation of IgE and release of biological active substances – tissue damage and clinical presentation; type II (cytotoxic); type III (Ag-Ab complexes); type IV (infectious, delayed). Autoimmune reactions. Definition. Types. Mechanisms of origin.

LECTURE №13 – 2 hours

Immunopathology. Immunodeficiency conditions and diseases. Autoimmunity.

Types of pathological conditions and diseases of the immune system – primary and secondary; Causes – defects in the cell-mediated immunity, humoral immunity, phagocytosis, and complement system; combined immunodeficiencies. Clinical presentation. Laboratory diagnosis. Immune status.

LECTURE №14 – 2 hours

Immunoprophylaxis and immunotherapy.

Immunoprophylaxis: vaccine prophylaxis – types of vaccines according to the origin; characteristics, duration of the post vaccinal immunity. Specific immunotherapy with serum and immunoglobulins. Types of immune serums – antitoxic, antibacterial, antiviral. Other methods and approaches for immunotherapy.

LECTURE №15 – 2 hours

Scheme and course of microbiological research.

Type of clinical specimens and tools for collection. Principles of collection and transport of clinical specimens for microbiological examination. Purpose of the microbiological examination. Course of microbiological examination: direct microscopy (types of smears – wet mount, stained – simple and complex staining methods, immunofluorescent smears); culturing – types of growth media, other requirements for culturing – atmosphere, temperature, humidity, time, etc.; method for obtaining a pure culture; identification of pure cultures – morphological, culture, biochemical,

antigenic. Antibiogram. Serological diagnosis. Rapid methods for microbiological diagnosis – ELISA, RIA, IFA, molecular methods – DNA probes, PCR. Automated systems – for blood cultures, identification of microorganisms, etc.

LECTURE №16 – 2 hours

Cocci - staphylococci, streptococci.

Family *Micrococcaceae*. *Staphylococcus spp.: S. aureus*. *Streptococcus* spp.: *S. pyogenes.*

LECTURE №17– 2 hours

***Streptococcus pneumoniae*. *Mycobacterium tuberculosis*. The causative agent of leprosy. Causative agents of mycobacteriosis.**

Streptococcus spp.: *S. pneumoniae*. Family *Mycobacteriaceae*. *Mycobacterium spp.*: *M. tuberculosis, M. leprae. M. kansasii, M. avium complex, etc.*

LECTURE №18 – 2 hours

Corynebacteria. Pertussis bacteria. *Hemophilus spp., Neisseria spp.*

Corynebacterium spp.: C. diphtheriae. Haemophilus spp.: H. influenzae. Neisseria spp.: N. meningitidis, N. gonorrhoeae. Bordetella spp.: B. pertussis, B. parapertussis.

LECTURE №19 – 2 hours

Anaerobes. Spore-forming - tetanus bacillus, gas gangrene bacilli, botulinum bacillus. Non-spore-forming anaerobes.

Family Clostridiaceae. Clostridium spp. C. tetani – causative agent of tetanus. Causative agents of gas gangrene - *C. perfringens, C. novyi, C. septicum, C. histolyticum*. Causative agent of botulism - *C. botulinum*. *Clostridioides spp.* Causative agent of pseudomembraneous collitis - *C. difficile*. Family *Bacteroidaceae*: *Bacteroides spp*. *Fusobacterium spp*. *Leptotrichia spp.*

LECTURE №20 – 2 hours

Causes of particularly dangerous infections. The causative agent of plague. *Vibrio cholerae*. *Bacillus anthracis*.

Family *Yersiniaceae: Yersinia spp.: Y. pestis, Y. enterocolitica.* Family *Vibrionaceae*. *Vibrio spp.: V. cholerae* biotype *cholerae*, *V. cholerae* biotype *El Tor*. *Bacillus spp.: B. anthracis.*

LECTURE №21 – 2 hours

Causes of particularly dangerous infections. *Brucella spp.* Tularaemia bacterium. Legionellosis. Facultative pathogenic intestinal bacteria - *Escherichia coli, Klebsiella spp., Proteus spp.*, and others.

Brucella spp. Francisella spp.: F. tularensis. Legionella spp.: L. pneumophila. Order *Enterobacterales.* Family *Enterobacteriaceae. Escherichia spp.: E. coli, Enterobacter spp., Citrobacter spp., Klebsiella spp.,* Family *Yersiniaceae: Serratia spp.* Family *Morganellaceae: Proteus spp., Providencia spp., Morganella spp.*

LECTURE №22 – 2 hours

Pathogenic enteric bacteria: Dysenteric bacteria. *Salmonella - Salmonella typhi*, *Salmonella paratyphi* A, B and C, *Salmonella spp.*, causes of food poisoning.

Family Enterobacteriaceae. Shigella spp. Salmonella spp.: S. typhi, S. paratyphi A, B, C. Salmonella spp., causing food toxoinfectious disease.

LECTURE №23 – 2 hours

Spirochetes. Cause of syphilis. Cause of typhus. Cause of Lyme disease. *Leptospira spp*. Spirilla.

Order *Spirochaetales*. Familly *Treponemataceae*. *Treponema spp*. *T. pallidum* – the causative agent of syphilis. Family *Borreliaceae*. *Borrelia spp.*: *B.* r*ecurrentis* – the causative agent of relapsing fever, *B.* b*urgdorferi* – the causative agent of Lyme disease. Family *Leptospiraceae*. *Leptospira spp. – L. interrogans*, *L. biflexa*.

LECTURE №24 – 2 hours

Mycoplasma and Rickettsia. Chlamydia spp.

Family Mycoplasmataceae. Genus Mycoplasma: M. pneumoniae, M. hominis, M. orale, M. salivarium, M. fermentans. Family Rickettsiaceae. Genus Rickettsia: R. prowazekii – causative agent of epidemic typhus, R. conorii – causative agent of Mediterranean spotted fever, etc. Family Coxiellaceae. Genus Coxiella. C. burnetii. Family. Chlamydiaceae. Genus Chlamydia: C. trachomatis. Genus Chlamydophila. C. pneumoniae. C. psittaci.

LECTURE №25 – 2 hours

Pathogenic fungi – Candida spp., Actinomycetes, Aspergillus spp., Cryptococci.

Genus Candida: C. albicans. Genus Actinomyces: A. bovis, A. israeli. Genus Aspergillus, Genus Cryptococcus.

LECTURE №26 – 2 hours

Viruses – nature and properties. Picornaviruses.

History of virology. General characteristics of viruses. Viral taxonomy. Morphology and structure of viruses: DNA/RNA genome, capsid, supercapsid; biology of virues: viral reproduction, cultivation methods. Epidemiology and pathogenesis of viral diseases; immunity, specific prophylaxis, therapy. Laboratory diagnosis. Family Picornaviridae. Genus Enterovirus: Human polioviruses 1, 2, 3. Human coxsackieviruses A, B. Human echoviruses. Human enteroviruses 68 – 71.

LECTURE №27 – 2 hours

Orthomyxoviruses. Paramyxoviruses. Causative agent of COVID-19 (SARS-CoV-2).

Family Orthomyxoviridae. Influenza A, B, C viruses – causative agents of Flu. Causative agents of bird flu and swine flu. Family Paramyxoviridae: Human Parainfluenza viruses 1-4, Morbillivirus, Mumps virus. Family Pneumoviridae – hRSV, Human Metapneumovirus. Family Coronaviridae. SARS-CoV, MERS-CoV, SARS-CoV-2.

LECTURE №28 – 2 hours

Adenoviruses. Togaviruses. Flaviviruses. Rhabdoviruses. Ebola and Zika viruses.

Family Adenoviridae. Family Togaviridae – Rubella virus and others. Family Flaviviridae – yellow fever virus, Zika virus and others. Family Rhabdoviridae – rabies virus. Family Filoviridae – Ebola virus.

LECTURE №29 – 2 hours

Hepatitis viruses. AIDS viruses.

Hepatitis viruses: Causative agents of viral hepatitis - HAV, HBV, HDV, HCV, HEV. Hepatitis viruses with fecal-oral transmission mechanism - hepatitis A and E viruses. Hepatitis viruses with multiple transmission mechanisms - hepatitis B, D, and C viruses. Characteristics of the virus, the clinical presentation of the disease, laboratory diagnosis (hepatitis markers), specific prevention, and therapy. Fam. Retroviridae. Subfamily Lentivirinae: AIDS viruses (HIV-1 and HIV-2). Acquired Immune Deficiency Syndrome (AIDS): historical data; structure and reproductive cycle of HIV; epidemiology of AIDS; Clinical presentation; laboratory diagnosis; therapeutic approach; prevention

LECTURE №30 – 2 hours

Herpesviruses. Poxviruses.

Family Herpesviridae. Subfamily Alpha herpes virinae: Herpes simplex virus 1, 2; Human herpes virus – 3, Varicella herpetovirus (V. varicellae, V. herpes zoster). Subfamily Beta herpes virinae: Human herpes virus 5 (Human cytomegalovirus). Subfamily Gamma herpes virinae: Human herpes virus 4 (Epstein-Barr herpes virus). Family Poxviridae: Orthopoxvirus variolae.

PRACTICAL CLASSES - THESES

PRACTICAL CLASS №1 – 3 hours

Structure and furnishing of the clinical microbiology laboratory, safety practices and rules. Methods for studying the morphology of microorganisms. Types of microscopes. Immersion oil microscopy. Simple staining methods - Loeffler and Pfeiffer.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the specifics of microbiological practice and basic microbiological materials. Mastering the microscopy slide preparation techniques and staining by the Loeffler and Pfeiffer methods. Working with immersion system on a light microscope.

DEMONSTRATION OF: Structure of a microbiological laboratory and safety rules upon handling infectious materials. Microbiological lab equipment, tools, and glassware. Basic microbiological manipulations and requirements when working with infectious materials. Work rules for immersion oil microscopy on a regular light microscope. Preparation of slides, stained by the Loeffler and Pfeiffer methods.

PRACTICAL TASKS: Preparation and staining microscopy slides by the Loeffler and Pfeiffer Пфайфер from microorganisms cultivated on solid and liquid growth media (S. epidermidis и E. coli). Observation and description of the microscopy field. Immersion oil microscopy of pre-stained slides. Diagnostic application of simple staining – microscopy of gonococci stained by the Loeffler method on a direct microscopy slide from urethral secretion. Microscopy of Helicobacter pylori in a slide from gastric mucosa biopsy, stained by the Pfeffer method.

PRACTICAL CLASS №2 – 3 hours

Complex staining methods. Gram and Neisser staining. Ziehl-Neelsen staining (for acid-fast bacteria). Moeller staining (spores).

PURPOSE OF THE PRACTICAL CLASS: Mastering the microscopy slide preparation and staining techniques by the Gram, Neisser, Ziehl-Neelsen and Moeller.

PRACTICAL TASKS: Gram staining and observation of a microscopy slide with a mixed culture of Gram / + / and Gram / - / bacteria. Staining by the Neisser method (for metachromatic granules) of a slide with diphtheroid bacteria and observation of a pre-made microscopy slide with Diphtheria bacteria. Preparation of a direct microscopy slide from sputum and staining it by the Ziehl-Neelsen and Kinyon methods. Detection of tuberculosis bacteria in a ready-made and stained microscopy slide from sputum. Preparation of a microscopy slide with spore-bearing bacteria (bacilli) and staining it by the Moeller method. Microscopy of ready-made slides of anthrax bacilli with central non-deforming spores.

PRACTICAL CLASS №3 – 3 hours

Cultivation of microorganisms. Types of growth media. Methods for isolation of microorganisms in pure culture. Types of microbial cultures and colonies.

PURPOSE OF THE PRACTICAL CLASS: To introduce students to the types of growth media and ways of their preparation and use. To master the streaking technique and methods for isolation of microorganisms in pure culture. To be able to characterize the bacterial growth on solid and liquid culture media.

DEMONSTRATION OF: Different types of ready-made solid and liquid sterile growth media. Cultures of various microorganisms on liquid and solid growth media - nutrient broth, glucose broth, nutrient agar, EMB agar, apocholate-citrate agar, blood agar, Lowenstein-Jensen agar, Zeissler agar and others. Different types of colonies. Streaking technique on Petri dishes with nutrient agar. Inoculation on agar slant. Preparation of inoculum in a deep agar.

PRACTICAL TASKS: Streaking *S. epidermidis* on nutrient agar from a pathological material – pus (primary inoculation). Subcultivation of S. epidermidis on agar slant. Inoculating a liquid nutrient medium with pathological material (pus). Description of microbial growth from ready-made cultures on liquid and solid media.

PRACTICAL CLASS №4 – 3 hours

Biochemical activity of bacteria. Pathogenic factors of bacteria.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the methods for biochemical (enzymatic) activity testing – part of the pure culture identification process. Introduction to the pathogenic factors of bacteria and laboratory methods for their determination.

DEMONSTRATION OF: IMVUC tests (conventional – in tubes and semi-automated in microplate systems as API). Tests for saccharolytic activity: decomposition of sugars with and without gas formation; the degree of acidity with methyl-red reagent; Voges-Proskauer test. Tests for proteolytic activity: formation of indole in tryptophan broth; hydrogen sulfide formation; urease activity, etc. Deamination and decarboxylation of the amino acids arginine, lysine, ornithine. Oxidase and catalase activity. Alpha- and beta- hemolysis of blood agar. Plasma coagulase test.

Plasma agglutination (clumping test). Microscopy of encapsulated bacteria (pneumococci and anthrax bacilli) stained by Klett. Identification by MALDI-TOF, Vitek-2 and other automatic methods.

PRACTICAL TASKS: Description of the growth on inoculated plates by the students in the previous practical class. Adding reagents to IMVUC tests and analyzing the results. Testing for indole with Ehrlich reagent. Degree of acidity of bacterial culture with a methyl-red reagent. Inoculating Kligler slant medium. Reporting the results from ready-made biochemical tests on Escherichia coli and Klebsiella pneumoniae. Plasma agglutination.

PRACTICAL CLASS №5 – 3 hours

Determination of the in vitro susceptibility of bacteria to antibiotics (antibiogram). Other methods for antimicrobial resistance detection.

PURPOSE OF THE PRACTICAL CLASS: To master the technique for preparing an antibiogram by the Bauer-Kirby disk-diffusion method and the principles of its reading and interpretation. To get acquainted with the principles of preparation of E-test, microdilution test, D-test, and phenotypic detection of ESBL producing strains and others.

DEMONSTRATION OF: Preparation and interpretation of a Bauer-Kirby antibiogram. Different types of phenotypic tests to determine in vitro antibiotic resistance. Printouts of mPCR samples with resistance gene detection.

PRACTICAL TASKS: Mastering the technique for preparing an antibiogram by the Bauer-Kirby disk-diffusion method. Reporting the results from ready-made antibiograms of different microbes. Reporting the results of pre-made: E-test, microdilution test, D-test, test for ESBL-producing strains.

PRACTICAL CLASS №6 – 3 hours

Resistance of microorganisms. Sterilization and methods of sterilization. Disinfection and disinfectants.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the devices and methods for sterilization and disinfectants.

DEMONSTRATION OF: The sterilization rooms in the department, Koch's apparatus, autoclave, and dry sterilizer. Materials, laboratory vessels and utensils to be sterilized. Method of packaging the laboratory utensils. Disinfectant solutions. Means for sterilization and disinfection control.

PRACTICAL CLASS №7 – 3 hours

Recapitulation of the studied material from practical classes from №1 to №8 included.

PURPOSE OF THE PRACTICAL CLASS: To establish knowledge and practical skills in microbiology.

PRACTICAL CLASS №8 – 3 hours

SEMINAR on the topic: Morphology, physiology, genetics and antimicrobial resistance of microorganisms. Test №1.

PURPOSE OF THE PRACTICAL CLASS: To consolidate the theoretical knowledge of the studied material. To check the knowledge gained from the lectures, practical classes and independent preparation of students on topics 1-8 of the syllabus.

PRACTICAL CLASS №9 – 3 hours

Cellular and humoral basis of the immune response. Antigen-antibody reactions. Agglutination reaction. Precipitation reaction. Neutralization reaction (ASLO).

PURPOSE OF THE PRACTICAL CLASS: Introduction to the morphology of cells involved in the immune response and the structure of antibodies and their functional areas. Mastering the technique for performing immune diagnostic reactions - agglutination and precipitation, their diagnostic significance, and interpretation.

DEMONSTRATION OF: Microscopy slides of blood smears with macrophages, leukocytes, lymphocytes, blast, and plasma cells. Types of agglutination reactions - Gruber and Widal. Types of precipitation reactions - Ascoli ring test, Mancini test, immunodiffusion in agar. ASLO (AST), turbidimetry and nephelometry.

PRACTICAL TASKS: Observation and drawing cells involved in the immune response. Performing Gruber agglutination test, Ascoli ring test. Interpretation of AST titers.

PRACTICAL CLASS №10 – 3 hours

Antigen-antibody reactions. Bacteriolysis, hemolysis, cytolysis. Complement fixation test (CFT). Immune reactions with labeled antibodies or antigens: immunofluorescence method (IFA), radioimmunoassay (RIA), enzyme-linked immunosorbent assay (ELISA).

PURPOSE OF THE PRACTICAL CLASS: Introduction to the technique of immune reactions CFT and the principles of marked immune reactions, their interpretation, and diagnostic value.

DEMONSTRATION OF: Hemolysis. Wasserman's complement-fixation test. ELISA equipment and ready-made ELISA plate. Immunofluorescence microscope and immunofluorescence test for *Chlamydia trachomatis* in cervical secretions.

PRACTICAL TASKS: Reading a Wasserman sample. Reporting positive and negative ELISA results from sera for anti-HCV, HBsAg or other suitable samples. Reading and reporting immunofluorescence test for Chlamydia and others.

PRACTICAL CLASS №11 – 3 hours

Flow cytometry for the determination of cellular subpopulations (immunophenotyping). Allergy testing. Biological products – vaccines and sera.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the operation principles of the flow cytometer and diagnostic capabilities of the equipment for immune status testing. Mastering the techniques of allergic tests for the diagnosis of fast and delayed type of hypersensitivity. Biological products used for specific therapy and prophylaxis of infectious diseases - vaccines and sera.

DEMONSTRATION OF: Flow cytometry test of a patient whole blood. Different types of vaccines – mandatory, according to the immunization calendar of the Republic of Bulgaria, recommended ones for different groups of people and for travelers. Antitoxic, antiviral and antibacterial sera. Guinea pig Mantoux allergy test.

PRACTICAL TASKS: Interpretation of flow cytometry protocol results Mastering the technique of the Mantoux test - intradermal injection of allergens.

PRACTICAL CLASS №12– 3 hours

SEMINAR on: Infection and immunity. Test №2.

PURPOSE OF THE PRACTICAL CLASS: To consolidate the theoretical knowledge on the material studied. To control the knowledge gained from lectures, exercises and independent preparation of students on topics №11-22 of the syllabus.

PRACTICAL CLASS №13– 3 hours

Laboratory diagnosis of diseases caused by viruses and rickettsia.

PURPOSE OF THE PRACTICAL CLASS: To introduce students to the particularities of the diagnosis of diseases caused by viruses and rickettsia.

DEMONSTRATION OF: Tissue cultures - normal and with cytopathic effect. Chicken embryos Hearst phenomenon and Hearst reaction (HIA). ELISA plate with positive and negative samples for HBsAg and anti-HCV antibodies. Immunofluorescence test.

PRACTICAL TASKS: Observation and drawing tissue cultures - normal and with cytopathic effect. Reporting the results from HIA in influenza, ELISA tests for hepatitis markers and HIV, immunofluorescence test for Chlamydia.

PRACTICAL CLASS №14 - 3 hours

Methods for microbiological diagnosis of infectious diseases. General scheme for microbiological examination.

PURPOSE OF THE PRACTICAL CLASS: Applying the acquired knowledge in a consecutive scheme for microbiological diagnosis of infectious diseases.

DEMONSTRATIONS AND PRACTICAL TASKS: Introduction to the general rules for collecting and sending pathological materials to the microbiological laboratory. Transport culture media. Preparation of a microscope slide from pathological material. Gram staining. Microscopy with immersion oil. Microscopy of ready-made slides. Recognition of pure microbial cultures on various growth media. Identification tests - cultural; biochemical; determination of pathogenic factors; serotyping by Gruber agglutination test. Antibiogram interpretation.

PRACTICAL CLASS №15 - 3 hours
Evaluation of the practical skills acquired during the semester.

PRACTICAL CLASS №16 - 2 hours
Microbiological diagnosis of staphylococcal and streptococcal infections.
Microbiological examination of pus.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the most common causative agents of purulent infections in the human body. Methods for microbiological diagnostics.

DEMONSTRATION OF: Prepared microscope slides with Gram-stained staphylococci and streptococci. Demonstration of the cultural features of staphylococci and streptococci on different growth media and tests for their identification. Methods for determination of methicillin-resistant staphylococci.

PRACTICAL TASKS: Identification of staphylococcal and streptococcal cultures on blood agar. Reporting alpha- and beta-hemolysis. Reading bacitracin and optochin test results. Performing

a coagulase slide test. Coagulase tube test reading. Result interpretation of antibiograms of staphylococci, beta-hemolytic, and viridans streptococci. Reading and interpretation of ASLO test. Differential diagnosis between alpha-hemolytic streptococci and pneumococci. MRSA screen agar – result interpretation.

PRACTICAL CLASS №17 - 2 hours

Microbiological examination in diseases caused by *Streptococcus pneumoniae.* Microbiological diagnosis of tuberculosis and leprosy. Microbiological examination of sputum.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the methods of collection and microbiological examination of sputum, features of the specific inflammatory process. Introduction to the microbiological diagnosis of tuberculosis, leprosy, and pneumococcal infections. Bioproducts for specific prevention and therapy.

DEMONSTRATION OF: Microscopic slides: a) Pneumococci stained by Klett method; b) Tuberculosis bacteria in sputum smear, stained by Ziehl-Neelsen method. Culture features of pneumococci on blood agar and glucose broth. Optochin and inulin test. Culture of tuberculosis bacteria on Lowenstein-Jensen agar. Gamma-interferon-based tests

PRACTICAL TASKS: Preparation of a microscopic smear of sputum and stain it by Ziehl-Neelsen staining for the detection of tuberculosis bacteria. Reporting the positive and negative optochin tests of alpha-hemolytic microorganisms. Reading an antibiogram of pneumococci on blood agar. Introduction to the principles of gamma-interferon-based tests. Introduction to bioproducts for specific prophylaxis (pneumococcal vaccine, BCG - vaccine) and for allergic diagnosis (PPD) of tuberculosis.

PRACTICAL CLASS №18 - 2 hours

Microbiological diagnosis of diphtheria and pertussis. Microbiological examination of throat swabs.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the microbiological diagnosis of diphtheria and pertussis and bioproducts for specific prophylaxis and treatment.

DEMONSTRATION OF: Ready-made microscope slides with diphtheria bacteria stained by the Neisser method. Cultural features of diphtheria bacteria in the Löffler and Klauberg media. Growth of *Bordetella pertussis* on the Bordet-Gengou culture media.

PRACTICAL TASKS: Microscopic observation of a ready-made microscope slide with *Bordetella pertussis,* Gram-stained. Preparation of a slide with pseudodiphtheria bacteria and Neisser staining. Introduction to bioproducts for specific prophylaxis (DTP and DT vaccines) and specific therapy for diphtheria (diphtheria antitoxin).

PRACTICAL CLASS №19 - 2 hours

Microbiological diagnosis of gas gangrene and tetanus. Microbiological examination of wound secretions.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the microbiological diagnosis of gas gangrene and tetanus, the particularities of collecting and sending pathological materials for anaerobic bacteria, and bioproducts for specific prophylaxis and therapy.

DEMONSTRATION OF: Ready-made microscope slides of *C. perfringens* and *C. tetani,* stained by the Gram method. Culture media for anaerobic bacteria - Kitt-Tarozzi, thioglycolate broth, Zeissler, and Wilson-Blair agars and the cultural features of gas gangrene agents and the tetanus bacillus. Tetanic seizure of a mouse injected with blood from a sick patient.

PRACTICAL TASKS: Preparation of a microscope slide with Gram-stained wound swab containing clostridia. Introduction to bioproducts for specific prophylaxis and therapy of gas gangrene and tetanus.

PRACTICAL CLASS №20 - 2 hours

Microbiological examination of CNS materials. Microbiological diagnosis and differential diagnosis of bacterial meningitis (*Neisseria meningitidis and Haemophilus influenzae*).

PURPOSE OF THE PRACTICAL CLASS: Mastering the differential microscopic diagnosis of bacterial meningitis.

DEMONSTRATION OF: Ready-made microscope slides from cerebrospinal fluid with *Neisseria meningitidis*, stained with methylene blue and Gram-stain, *H. influenzae*, stained by the Gram method and other microorganisms, causing bacterial meningitis. Cultural features of *H. influenzae* on chocolate agar, Levinthal agar, and blood agar – satellite phenomenon. Methods for microanaerophilic cultivation and cultures of *Neisseria meningitidis* on Levinthal agar and blood agar. Other causative agents of bacterial meningitis - pneumococci, staphylococci, streptococci and tuberculosis bacteria. Latex agglutination tests to detect microbial antigens in the cerebrospinal fluid of patients

PRACTICAL TASKS: Preparation of a microscope slide with cerebrospinal fluid and stained by the Gram method. Observation of ready-made microscope slides with *Neisseria meningitidis and H. influenzae*. Reporting the phenomenon of satellite growth in *H. influenzae.*

PRACTICAL CLASS №21 - 2 hours

Microbiological diagnosis of particularly dangerous infections plague, cholera, and anthrax.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the microbiological diagnosis of plague, cholera, and anthrax and the relevant bioproducts for specific prophylaxis and therapy.

DEMONSTRATION OF: Ready-made microscopic slides - blood smear with *Bacillus anthracis*, stained by the Klett method for capsules and Moeller - for spores, *Vibrio cholerae* - stained by the Gram method and *Yersinia pestis* - stained by Giemsa method. Culture media, bacterial cultures, and biochemical tests for identification of *Vibrio cholerae*. Ascoli precipitation test for anthrax antigen.

PRACTICAL TASKS: Microscopy and drawing of a slide with B. anthracis, V. cholerae and Y. pestis. Performing the Ascoli precipitation test. Immunofluorescence microscopy of B. anthracis.

PRACTICAL CLASS №22 - 2 hours

SEMINAR on the topic: Microbiological diagnostics of microorganisms, studied in practical classes from №1 to №7. Test №1.

Staphylococcus spp. Streptococcus spp. Streptococcus pneumoniae. Tuberculosis bacteria and other mycobacteria. Mycobacterium leprae. Neisseria meningitidis. Corynebacterium diphtheriae. Bordetella pertussis. Haemophilus influenzae. Causative agents of gas gangrene. Clostridium tetani. Bacillus anthracis. Vibrio cholerae. Yersinia pestis

PRACTICAL CLASS №23 - 2 hours

Microbiological examination of materials from the digestive system (feces). Microbiological diagnosis of bacterial dysentery, E.coli enteritis, salmonellosis. Food poisoning by Staphylococcus aureus, salmonella, and clostridia (C. botulinum, C. perfringens). Microbiological examination of gastric mucosa biopsy material (Helicobacter pylori).

PURPOSE OF THE PRACTICAL CLASS: Introduction to the scheme for bacteriological examination of feces in diseases caused by members of the family Enterobacteriaceae (pathogenic E. coli, Shigella, Salmonella). Introduction to the microbiological diagnosis of food poisoning by bacterial agents and methods for bacterial diagnosis of Helicobacter pylori from biopsy material.

DEMONSTRATION OF: Microscope slide with Gram-negative microorganisms. Selective and differentiating media for enteric bacteria - Levine, deoxycholate-citrate agar with cultures of lactose-positive and lactose-negative bacteria; blood agar with S. aureus; culture media for clostridia. Biochemical tests for identification. Serotyping by agglutinating sera. Microscopic preparation of H. pylori.

PRACTICAL TASKS: Preparation of a microscope slide from a culture of E. coli and Gram staining. Performing biochemical tests - indole formation, acidity (MR), Voges-Proskauer test, etc. Performing type Gruber agglutination test. Inoculation of feces on a differentiating medium.

PRACTICAL CLASS №24 - 2 hours

Microbiological examination of urine. Microbiological diagnosis of pathogens causing urinary tract infections: opportunistic pathogens (E. coli, Klebsiella, Proteus-Providentia-Morganella, Pseudomonas) and obligatory pathogenic (streptococci, salmonella, leptospira, M. tuberculosis).

PURPOSE OF THE PRACTICAL CLASS: To introduce the rules for collection and sending urine for bacteriological examination and the methods for detection and isolation of the most common bacterial agents.

DEMONSTRATIONS OF: Cultural and biochemical features of E. coli, Klebsiella, Proteus, Pseudomonas. Inoculation of urine culture by the quantitative method with a calibrated loop. Demonstration of leptospira in a wet mount slide on dark-field microscopy. Ready-made microscopic preparations of Gram-negative rods, streptococci, tuberculosis bacteria.

PRACTICAL TASKS: Inoculation of urine on Levine agar with calibrated loop. Reading and interpretation of urine cultures with different degrees of bacteriuria - determination of microbial count. Observation and drawing of leptospira. Interpretation of an antibiogram of microorganisms isolated from urine.

PRACTICAL CLASS №25 - 2 hours

Microbiological examination for sexually transmitted infections caused by Neisseria gonorrhoeae, Treponema pallidum, C. albicans, chlamydia, and mycoplasmas.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the morphology and biology of the most common causative agents of sexually transmitted infections.

DEMONSTRATIONS OF: Ready-made microscope slide of urethral smear with N. gonorrhoeae; ready-made microscope slide with Candida albicans. Immunofluorescence slide with elementary bodies of chlamydia in cervix cells. Bacterial cultures of Candida albicans on Sabouraud agar; chlamydospores of Candida albicans on rice agar; filamentation test. ELISA. Incolulation of fungi on ChromagarCandida. sowing of ChromagarCandida fungi. Positive and negative CFT (Wasserman) and VDRL tests - as screening tests for syphilis. Multiplex PCR - results from a patient.

PRACTICAL TASKS: Microscopy and recognition of N. gonorrhoeae in Gram and Loffler-stained urethral secretions. Reporting positive and negative samples of Wasserman and VDRL test. Observation and detection of chlamydospores of Candida albicans on rice agar. Working with mPCR protocols for sexually transmitted infections.

PRACTICAL CLASS №26 - 2 hours

Microbiological examination of blood - blood culture. Causative agents of septic conditions: obligatory pathogenic (Salmonella typhi, Brucella, Borrelia) and facultative pathogenic bacteria.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the microorganism cause bacteremia and sepsis and methods for the microbiological examination of bloodstream infections - conventional and automatic methods.

DEMONSTRATION OF: Blood culture media - soy-casein broth, thioglycollate broth, etc. Salmonella spp. and Proteus spp. cultures on Levine agar, deoxycholate-citrate agar and selenite broth. IMVUC tests of *Salmonella typhi* and *Proteus mirabilis*. Brucella culture media. Microscopic preparations of Salmonella spp. and Brucella spp. according to Gram stain. Cultures of streptococci and staphylococci on blood agar and tests for their identification. Analytical Vidal for typhoid fever and Right's agglutination for brucellosis.

PRACTICAL TASKS: Observation of ready microscopic slides. Reporting of positive and negative blood cultures cultured in the BactAlert apparatus. Characterization of salmonella and proteus growth on differentiating media. Reporting conventional tests for identification and the API system for Salmonella typhi and Proteus mirabilis. Determination of sample titers of Vidal and Right.

PRACTICAL CLASS №27 - 2 hours

Problematic microorganisms causing nosocomial and iatrogenic infections - Pseudomonas, Acinetobacter, Enterococcus, MRSA, C. difficile. Systemic mycoses caused by Candida, Aspergillus, Actinomyces, and Cryptococcus. Antifungal therapy.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the most common microorganisms that caused nosocomial and iatrogenic infections, methods for microbiological diagnosis, and interpretation of results. Introduction to the causative agents systemic mycoses - Candida, Aspergillus, Actinomyces, Cryptococcus and modern antifungal therapy

DEMONSTRATION OF: Cultures, identification tests, and AST of Pseudomonas, Acinetobacter, Enterococcus, MRSA. ELISA test for C. difficile toxins. Cultures, tests for the identification of Candida, Aspergillus, Actinomyces, Cryptococcus, and E-tests for antifungal drugs.

PRACTICAL TASKS: Reporting and identification of cultures, AST of multidrug-resistant Pseudomonas and Acinetobacter. Determination of ESBL (+) E. coli. Determination of MRSA and MSSA strains on MRSA screen agar. Reading AST of vancomycin-resistant enterococci - VRE. Resistance gene detection by mPCR. Characterization of cultures of Candida, Aspergillus, Actinomyces, Cryptococcus and reporting E-tests for antifungal drugs -voriconazole, anidulafungin, caspofungin, and others.

PRACTICAL CLASS №28 - 2 hours

Microbiological diagnosis of diseases caused by viruses - HIV, hepatitis A, B, C, D, and E, flu, and coronaviruses - SARS-CoV-2.

PURPOSE OF THE PRACTICAL CLASS: Introduction to the specificities of the viral diagnosis, viruses important for human pathology.

DEMONSTRATION OF: Hearst phenomenon and Hearst reaction (HFA) for Influenza viruses. ELISA - conventional and automated and CLIA equipment; real-rime PCR and mPCR. ELISA samples for the diagnosis of viral markers (HBsAg, anti-HCV antibodies, anti-HIV-1,2 antibodies, etc.). mPCR for detection of influenza viruses, SARS-CoV-2, etc. respiratory pathogens.

PRACTICAL TASKS: Performing an ELISA test for anti-HCV antibodies. Reporting and interpretation of the result. Reporting of results from the mPCR respiratory panel - with SARS-CoV-2.

PRACTICAL CLASS №29 - 2 hours

Sanitary-microbiological examination of water, air, hospital environment. Sanitary-indicative microorganisms - E. coli, Enterococcus, C. perfringens, staphylococci, streptococci. TEST (practical classes №8-13)

PURPOSE OF THE PRACTICAL CLASS: Introduction to the methods of collection, transport, and basic scheme for sanitary-microbiological examination. Criteria for the identification of microorganisms as nosocomial agents.

DEMONSTRATION OF: Nutrient media and materials needed to determine the microbial count and *E.coli* titer in the sanitary-microbiological examination of water. Biochemical tests for differentiation of *E. coli* and *Klebsiella* - IMVUC. Sedimentation plates method for microbial air monitoring. Enterococcal nutrient media and cultures. Sherman's test.

PRACTICAL TASKS: Taking a hand swab for sanitary-microbiological examination and broth inoculation. Identification of *E. coli*, *Klebsiella*, *Enterococcus, C. perfringens*. Determination of microbial biotype, serotype, resistotype, etc. Identifying intrahospital infections. Characterization of the growth of *Staphylococcus* and *Streptococcus* strains on blood agar and identification according to specific tests.

EXERCISE №30 - 2 hours

Recapitulation of the students' practical skills, acquired during the two semesters with an evaluation mark.

SYLLABUS FOR THE SEMESTER EXAM

GENERAL MICROBIOLOGY

1. Subject and tasks of microbiology. Pasteur and Koch's contributions to the development of microbiology. Taxonomy of microorganisms - nomenclature and classification. General characteristics of the separate groups of microorganisms.
2. Morphology of bacteria - basic shapes, size. Methods for studying the morphology of bacteria. Bacterial structure - capsule, bacterial wall, cytoplasmic membrane, cytoplasm, and cytoplasmic inclusions. Flagella, pili, spores.
3. Bacterial genetics. Bacterial genotype and phenotype. Genetic apparatus in bacteria. The bacterial chromosome as a genetic system. Extrachromosomal genetic elements. Bacteriophages - main types, structure. Forms of the interaction of bacteriophages with bacteria - lytic cycle, moderate phage, phage conversion. Phage typing. Practical applications.
4. Microbial variability. Mutation. Mutagenic factors - chemical and physical, mechanism of action, practical significance, and application. Genetic exchange between bacteria: transformation, transduction, conjugation - mechanisms. Significance of bacterial and phage genetics. Genetic engineering. Modern genetic methods in clinical microbiology. DNA probes, PCR - polymerase chain reaction.
5. Bacterial physiology. Chemical composition of bacteria. Types of bacterial enzymes and their practical significance. Metabolism in bacteria - catabolic and anabolic processes. Bacterial respiration. Bacterial nutrition. Nutrient transfer.

6. Growth and multiplication of bacteria. Growth phases and growth curves. Bacterial cultivation - basic principles, types of nutrient media. Growth factors in bacteria.
7. Influence of physical factors on microorganisms: heat, drying, lyophilization, light, atmospheric pressure, osmotic pressure, pH, radiation, sound energy. Sterilization. Sterilization methods. Influence of chemical factors on microorganisms; Mechanism of action. Oligodynamic effect. Disinfection. Types of disinfectants. Influence of biological factors on microorganisms: symbiosis, antagonism, antibiosis
8. Antimicrobial agents. Antibacterial drugs - main groups and mechanisms of action. Mechanisms of resistance. Determination of bacterial susceptibility to antibiotics.
9. Viruses. Nature and properties. Cultivation methods. Classification. *Rickettsia*. Nature and properties. Cultivation methods. Classification.
10. The external environment as a factor in the spread of infectious diseases. Microflora of water, soil, and air. Microorganisms in food products, hospital rooms, etc. Sanitary-indicative microorganisms in the environment.

INFECTION AND IMMUNITY

11. Infection and infectious process. The role of microorganisms in the infectious process. Pathogenicity, virulence, contagiousness, invasiveness, toxigenicity. Pathogenicity factors. Pathogenesis of the infectious process. Characteristics of infectious disease. Forms of the infectious process. The role of the macroorganism in the infectious process. The role of the external environment for the occurrence and course of the infectious process. Epidemic process. Factors and mechanisms of transmission of infectious agents in the epidemic process.
12. Natural resistance. Protective role of the skin, mucous membranes, organs, and normal microflora. Humoral factors of natural resistance. Lysozyme. Complement. Interferon. Cellular factors of natural resistance. Phagocytosis. Inflammation.
13. Immunity. Definition. Types of immunity. Anatomy and structure of the immune system. Central and peripheral immune organs. Cells of the immune system.
14. Antigens. Types of antigens. Antigenic characteristics of microorganisms.
15. Humoral immunity. Characteristics of antibodies (immunoglobulins). Structure and functions of different classes of immunoglobulins. Mechanism of action of antibodies. Local immunity.
16. Cellular immunity. Cells and mechanism of action. Forms of cellular immunity. Cellular cooperation in the immune response.
17. Development of the immune response. Dynamics of the immune response – primary and secondary immune response. Humoral regulation of the immune response. Genetics and genetic control of the immune response. APC. The role of MHC - antigen recognition molecules
18. Allergy - definition and forms. Fast type of allergy - anaphylaxis, atopy, clinical significance. Cytotoxic allergic reactions. Allergic phenomena of immune complexes – Arthus phenomenon, serum sickness, clinical significance. Slow type of allergy - cell-mediated hypersensitivity. Contact dermatitis. Clinical significance.
19. Immunopathology. Immunopathological reactions and diseases. Immunological tolerance. Autoimmune diseases. Immunodeficiency conditions and diseases. Infectious diseases of the immune system.
20. Antigen-antibody reaction. Types of immune diagnostic reactions - agglutination, precipitation, neutralization - toxin-antitoxin, AST, virus-neutralizing reaction. Complement dependent - bacteriolysis, cytolysis, hemolysis, complement fixation test (CFT). Mechanism of reactions and application in microbiological diagnostics.

21. Labeled immune reactions - immunofluorescence (IFA), radioimmune (RIA) and enzyme-linked immunosorbent assay (ELISA) tests. Hybridoma biotechnology. Monoclonal antibodies.
22. Immunoprophylaxis and immunotherapy. Vaccines and serums. Immunomodulation.

MICROBIOLOGY

23. Staphylococci. (*Staphylococcus*) Species, morphology, biology, biochemical productivity, pathogenicity factors. Signs of pathogenicity in staphylococci. Diseases, immunity. Microbiological diagnosis. Antibiotic therapy. MRSA - clinical significance and diagnosis.
24. Streptococci (*Streptococcus*). Classifications. Morphology, biology, antigenic structure, pathogenicity factors. Diseases. Immunity. *Streptococcus* as a cause of scarlet fever. Microbiological diagnosis. Antibiotic therapy. Pneumococci (*Streptococcus pneumoniae*). Morphology, biology, biochemical productivity. Antigenic structure. Pathogenicity factors. Diseases. Immunity. Microbiological diagnosis. Therapy and specific prevention.
25. Meningococci (*Neisseria meningitidis*). Morphology, biology, biochemical productivity. Antigenic structure - serogroups. Pathogenicity factors. Pathogenesis and clinical forms of meningococcal infection. Immunity. Microbiological diagnosis. Specific prevention and therapy. Gonococci (*Neisseria gonorrhoeae*). Morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis and clinical forms of gonococcal infection. Immunity. Microbiological diagnosis. Prevention and therapy.
26. Family Enterobacteriaceae. Groups of intestinal bacteria according to pathogenicity. General characteristics: morphology, biology, biochemical productivity. Antigenic structure. Pathogenicity factors. Properties of endotoxin. Coli bacteria (*Escherichia coli*). Morphology, biology, biochemical productivity. Antigenic structure. Pathogenicity factors. Diseases. Pathogenic *Escherichia coli* in the intestinal tract. Immunity. Microbiological diagnosis.
27. *Proteus*. *Providencia*. *Morganella*. Species. General characteristics: morphology, biology, biochemical productivity. Diseases. Therapy. Microbiological diagnosis. Tribus *Klebsiellae*. Species. Morphology, biology, biochemical productivity. Pathogenicity factors. Diseases. Immunity. Microbiological diagnosis. Therapy. *Pseudomonas*. Morphology, biology, biochemical productivity. Pathogenicity factors. Diseases. Microbiological diagnosis. Therapeutic problems.
28. *Salmonella*. General characteristics: morphology, biology, biochemical productivity. Kaufman antigenic characterization and classification. Antigenic formulas. Pathogenicity factors. Pathogenesis, immunity, and specific prophylaxis in typhoid and paratyphoid fever. *Salmonella* – as causative agents of food poisoning. Characteristic. Microbiological diagnosis.
29. Dysenteric bacteria (*Shigella*). Classification. Morphology, biology, biochemical productivity. Antigenic structure. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. *Helicobacter pylori*. Morphology, biology, biochemical productivity. Diseases. Microbiological diagnosis. Therapy. *Clostridium difficile*. Morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Therapy.
30. The causative agent of plague (*Yersinia pestis*). Morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Specific prevention and therapy. *Yersinia enterocolitica* - morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis. Microbiological diagnosis.

31. *Vibrio cholerae*. Morphology, biology, biochemical productivity. Antigenic structure. Serological types. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Specific prevention and therapy.
32. Pertussis and pertussis bacteria (*Bordetella pertussis*, *B. parapertussis*). Morphology, biology. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Specific prevention and therapy. Genus *Haemophilus*. Morphology, biology. Antigenic structure. Pathogenicity factors. Diseases. Immunity. Microbiological diagnosis. Specific prevention and therapy. *Listeria monocytogenes*. General characteristics.
33. *Brucella*. Species. Morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Specific prevention. Causative agent of tularaemia (*Francisella tularensis*) - general characteristics. *Legionella pneumophila* - general characteristics.
34. Causative agent of diphtheria (*Corynebacterium diphtheriae*). Morphology, biology, biochemical productivity. Pathogenicity factors. Pathogenesis and immunity. Microbiological diagnosis. Specific prevention and therapy. Diphtheroid bacteria (*C. jeikeium, C. urealyticum, C. amiculatum, C. pseudo-diphtheriticum*). Clinical significance.
35. *Mycobacterium*. Causative agent of tuberculosis (*Mycobacterium tuberculosis*). Morphology, biology, pathogenesis, clinical forms, immunity, allergy. Specific prevention of tuberculosis. Therapy. Microbiological diagnosis. The causative agent of leprosy (*Mycobacterium leprae*). Morphology, biology. Pathogenesis. Clinical forms. Prevention. Microbiological diagnosis.
36. Causative agent of anthrax (*Bacillus anthracis*). Morphology, biology. Pathogenesis, clinical forms. Immunity. Specific prevention and therapy. Microbiological diagnosis. The causative agent of typhoid fever (*Borrelia recurrentis*). Morphology, biology. Pathogenesis, immunity. Microbiological diagnosis. The causative agent of Lyme disease (*Borrelia burgdorferi*). Pathogenesis. Immunity. Microbiological diagnosis
37. Anaerobic spore-forming bacteria - genus *Clostridium*. General characteristics - morphology, biology. Tetanus bacillus (*Clostridium tetani*). Pathogenicity factor. Pathogenesis and immunity. Specific prevention and therapy. Microbiological diagnosis. Causative agents of gas gangrene (*C. perfringens, C. novyi, C. septicum C. histolyticum*). Pathogenicity factors. Pathogenesis, immunity, prevention, and therapy. Microbiological diagnosis. The causative agent of botulism (*C. botulinum)*. Pathogenicity factor. Pathogenesis and immunity. Prevention and specific therapy. Microbiological diagnosis.
38. Spirochetes (family Spirochaetaceae) - general characteristics. The causative agent of syphilis (*Treponema pallidum*). Morphology, biology. Pathogenesis and immunity. Microbiological diagnosis. *Leptospira*. Species. Morphology, biology. Antigenic structure. Pathogenesis and immunity. Microbiological diagnosis
39. Genus *Mycoplasma*. Classification. Morphology, biology. Diseases. Microbiological diagnosis. L-forms of bacteria. Genus *Chlamydia*. General characteristics. Species. Causative agents of ornithosis and trachoma. Morphology, biology. Pathogenesis. Diseases. Microbiological diagnosis
40. The causative agent of typhus (*Rickettsia prowazekii*). Morphology, biology. Pathogenesis and immunity. Specific prevention. Microbiological diagnosis. The causative agent of Marseille fever (*Rickettsia conorii*). Morphology, biology. Pathogenesis and immunity. Microbiological diagnosis. The causative agent of Q fever (*Coxiella burnetii*). Morphology, biology. Microbiological diagnosis.
41. Pathogenic fungi (*Fungi*). Candida (genus *Candida*). Morphology, biology. Pathogenesis, clinical forms. Microbiological diagnosis. Therapy. *Aspergillus*, *Cryptococcus*, Actinomycetaceae. Morphology, biology, diseases, and microbiological diagnosis.

VIROLOGY

42. Family Picornaviridae. Genus *Enterovirus* - *poliovirus*, *Coxsackie viruses*, *ECHO viruses*. Genus *Rhinovirus*. Genus *Aphtovirus* - the causative agent of foot-and-mouth disease.
43. Family Orthomyxoviridae. *Influenza viruses*
44. Family Paramyxoviridae - *parainfluenza viruses*; the causative agent of mumps; the causative agent of measles. Respiratory syncytial virus.
45. Arbovirus infections and rubella. The family Togaviridae - genus *Alphavirus* and genus *Rubivirus*. Family Flaviviridae - causative agents of yellow fever, dengue, pappataci fever, tick-borne encephalitis. Family Bunyaviridae – causative agents of Crimean hemorrhagic fever and hemorrhagic fever with renal syndrome.
46. Family Poxviridae - the causative agent of smallpox. Family Adenoviridae.
47. Family Retroviridae - the causative agent of AIDS. Family Rhabdoviridae – the causative agent of rabies.
48. Family Herpesviridae - Herpes simplex virus type 1 and 2, Varicella-Zoster virus, *Cytomegalovirus*, Epstein-Barr virus, other herpes viruses.
49. Causative agents of viral hepatitis (HAV, HBV, HCV, HDV, HEV).
50. Family Coronaviridae. SARS-CoV-2, the causative agent of COVID-19.

Obligatory Sources for Self-Study:

Student books:

1. Medical Microbiology Textbook for students of medicine, dentistry and pharmacy. Third major revised and expanded edition. Edided by Ivan Mitov, ARSO – Sofia, 2024, ISBN: 987-619-197-088-9.

2. Murray P, K. Rosenthal, M. Pfaller, Medical Microbiology, 10th edition, 2025, ELSEVIER, ISBN: 9780443261336.

3. A lecture course with outlines available on the website of the Medical University of Plovdiv or on SharePoint of MS Office 365.

Manuals:

1. Manual for Practical Exercises in Medical Microbiology – Part I, edited by Ivan Mitov and Rayna Gergova, 2nd edition, year of publication: 2025, Medical Publishing House “Arso

2. Manual for Practical Exercises in Medical Microbiology – Part II, edited by Rayna Gergova, year of publication: 2025, Medical Publishing House “Arso”

Recommended literature:

1. Levinson W, Review of Medical Microbiology and Immunology, 17th edt, 2022, McGraw-Hill Education, ISBN: 978-1264267088.

2. Samaranayake L, Essential of Microbiology for Dentistry, 6th edition, 2024, Elsevier, ISBN: 978-0443118210

Topics for Essays / Reports

1. Recombinant DNA technology in the production of vaccines and antibiotics
2. Modern vaccines in the Republic of Bulgaria – types, production, and application
3. Hybridoma biotechnology – essence and role in the pharmaceutical industry
4. Immune sera – production and application
5. Antibiotic policy in a healthcare facility – principles and the role of the hospital pharmacist
6. Phenotypic and genetic mechanisms of bacterial resistance to beta-lactam antibiotics
7. Antifungal agents – types, mechanism of action, and application
8. Antiviral drugs for prevention and treatment
9. Replacement therapy in immunodeficiencies
10. Determination of microorganisms in pharmaceutical raw materials and medicinal products

Questions for Self-Study
In accordance with the topics covered in lectures and practical exercises

Self-Assessment Tests
The department is preparing a study guide with tests and case studies in microbiology for students at medical universities

Test for Microbiology Trial Exam

1. Flagella in bacteria have adhesive function:

a) Yes b) No

2. Endotoxins are proteins:

A) True B) False

3. Is it true that microaerophilic bacteria grow in an environment with reduced oxygen concentration:

A) True B) False

4. Autoclaving is an effective method for moist heat sterilization against vegetative cells but not against bacterial spores:

A) True B) False

5. Antibiotic resistance is the development of resistance in human cells to antibiotics:

A) True B) False

6. NK cells play an important role in antiviral protection:

A) Yes B) No

7. There are two main mechanisms for intracellular killing of bacteria in phagocytosis:

A) Yes B) No

8. The immune system does not have the ability to distinguish itself from foreign antigens:

a) true b) false

9. Tetanus toxoid is a vaccine produced by detoxifying the *Clostridium tetani* exotoxin:

A) True B) False

10. Haptens are defective antigens having the ability to induce the formation of antibodies and to bind to them:

A) True B) False

11.There is incomplete phagocytosis observed in *M. tuberculosis* infection:

A) Yes B) No.

12. Enteric bacteria from *Enterobacterales* are spore-forming:

a) true b) false

13. *Haemophilus influenzae* is a Gram-positive cocobacterium:

a) true b) false

14. The causative agent of syphilis is *Treponema vincentii*:

A) Yes B) No

15. *Chlamydia* are obligate intracellular parasites:

a) true b) false

16. Western-blot is a confirmatory *HIV* test:

a) True b) False

17. The serological diagnosis of viral infections is based on the patient's specific humoral immune response:

a) True b) False

18. Some viruses have an additional envelope - envelope, located under the capsid:

a) Yes b) No

19. Viruses can be cultured on agar media and cell cultures:

A) Yes B) No

20. *Hepatitis E* is transmitted parenterally:

a) True b) False

21. Which structure is specific only for prokaryotes:

a) ribosomes b) peptidoglycan

b) cytoplasmic membrane d / DNA

22. For observing after cultivation most bacterial colonies require:

a / 2 hours

b / 20-30 minutes

c / 1 week

d / 24-48 hours

23. Which phase of the growth curve of the bacterial population, developing in a closed system, is characterized by equalization of the number of living and the number of dead bacteria:

a / Lag phase

b / logarithmic phase

c / stationary phase

d / dying phase

24. The mesosomes of bacteria are:

a) nutrient c / mitochondrial equivalent

b / organelles for attachment d / motility organelles

25. Bacterial size is measured in:

a / millimeters c / nanometers

b / micrometers d / picometers

26. The secondary immune response is characterized by the production of antibodies class:

a) IgG

b) IgM

c) IgA

d) IgD

27. NK cells and cytotoxic T- lymphocytes have a major protective role in immunity against:

a) viruses and tumors

b) toxigenic bacteria

c) extracellular bacteria

d) intracellular bacteria

28. Interferon-gamma based tests are used to diagnose tuberculosis infection and are based on increased lymphocyte secretion of:

a) antibodies

b) interferon

c) acute phase proteins

d) oxygen radicals

29. Example of a delayed allergic reaction is:

a) anaphylactic shock

b) serum sickness

c) Mantoux test

d) hemolytic disease

30. Which of the antibodies can pass through the placenta?

a) IgG

b) IgM

c) IgA

d) IgD

31. *Shigella spp.* are causative agents of the following disease:

a / gas gangrene

b / dysentery

c / diphtheria

d / whooping cough

32. The formation of pseudomembranes in the throat is observed in:

a) tuberculosis

b) whooping cough

c) diphtheria

d) tetanus

33. Which of the following statements about tuberculosis bacteria is true:

a) have metachromatic bodies

b) form terminally located spores

c) they are straight or slightly curved rods

d) have a capsule

34. Which of the following morphological characteristics are specific for *C. perfringens*?

a) Gram-negative bacteria with subterminally located spores

b) Gram-positive rod with a centrally located spore

c) forms a terminally located dispute

d) Gram-negative bacteria that have a terminal spore

35. *Vibrio cholerae* causes:

a) sexually transmitted infection

b) acute meningoencephalitis

c) acute gastroenteritis with loss of water and electrolytes

d) hemorrhagic inflammation of the colon

36. There is a vaccine available against all of the following diseases EXCEPT:

a / rubella

b / measles

c / mumps

d / hepatitis C

37. Laboratory screening for HIV seropositivity is initially performed by:

a) neutralization test

b) complement fixation reaction

c) ELISA method

d) passive hemagglutination

38. Which of the following viruses are characterized by high antigenic variability:

a) rabies virus

b) influenza virus type A

c) measles virus

d) hepatitis C virus

39. Which class of specific antibodies is found in high titer in the serum of a baby with congenital rubella:

a / IgG

b / IgA

c / IgM

d / IgE

40. The *AIDS* virus is transmitted by all of the following mechanisms EXCEPT:

a) parenteral

b) sexual

c) transplacental

d) airborne

41. Pilli in bacteria can be used for:

a) movement

b) nutrition

c) conjugation

d) breathing

e) adhesion

f) survival

42. Which of the following elements is found only in the cell wall of Gram-negative bacteria:

a) D-amino acids

b) teichoic acids

c) teichuronic acids

d) lipid A

e) peptidoglycan

f) O-specific polysaccharide

43. Which structures of bacteria are made up of proteins?

a) glycocalyx

b) spores

c) axial filaments

d) lipopolysaccharide

e) fimbriae

f) peptidoglycan

44. Indicate the correct statements concerning macrolide antibiotics:

a) a preferred group as an alternative for oral treatment of patients with penicillin allergy

b) act with the mechanism of inhibiting the synthesis of nucleic acids

c) this group includes Erythromycin, Clarithromycin, Azithromycin and others

d) used to treat severe nosocomial infections

e) may not be used in young children and pregnant women

f) act with the mechanism of inhibiting cell wall synthesis

45. For specific immune prophylaxis and treatment of tetanus after injury or bite of an animal shall be applied:

a / live attenuated vaccine

b / aminoglycosides

c / toxoid (toxoid)

d / killed vaccine

e / antitoxic serum

f / hyperbaric chamber

46. There is an abundant local immune response in:

a) tuberculosis

b) polio

c) plague

d) gonorrhea

e) AIDS

f) diphtheria

47. Cell-mediated immunity involves:

a) B-lymphocytes

b) Th-lymphocytes

c) NK cells

d) macrophages

e) segmental leukocytes

f) Tc-lymphocytes

48. Which of the following antibodies can activate the complement:

a) IgA

b) IgD and IgM

c) IgM

d) IgE

e) IgG and IgA

e) IgG

49. All listed vaccines are mandatory EXCEPT:

a) anti-pertussis

b) anti-tuberculosis

c) anti-plague

d) anti-diphtheria

e) anti-cholera

f) anti-tetanus

50. Meningococcal disease can be clinically manifested as:

a) enterocolitis

b) meningitis

c) acute hepatitis

d) cervicitis

e) pyelonephritis

f) Waterhouse-Friedrichsen syndrome

51. The characteristic location of *pneumococci* in a direct microscopic slide is:

a) in pairs

b) in groups such as clusters

c) in tetrads

d) intracellular

e) extracellular

f) palisade

52. Which statements about gonococci are true:

a) they are Gram-positive cocci arranged in chains

b) they are Gram-negative renal cocci arranged in pairs

c) virulent strains have adhesive pili

d) the most important pathogenic factor is an exotoxin

e) have a protein capsule

f) not located intracellularly

53. Suitable media for cultivation of anaerobic bacteria are:

a) thioglycolate broth

b) Löfler agar

c) Zeissler agar

d) TCBS agar

e) simple agar

f) Bordet-Gengou agar

54. Which of the following microorganisms cause diarrheal infections in humans:

a) *Treponema pallidum*

b) *Helicobacter pylori*

c) *Vibrio cholerae*

d) *Yersinia enterocolitica*

e) *Borrelia recurrentis*

f*) Listeria monocytogenes*

55. Psittacosis is a disease:

a) in which there are many species of poultry and wild birds as a reservoir

b) which is anthroponosis

c) which is represented clinically as atypical pneumonia

d) which is treated with penicillin

e) which can be complicated by colitis

f) which is sexually transmitted

56. Indicate the specific clinical manifestations of the first stage in the development of syphilis:

a) syphilitic skin lesions

b) hard painless ulcer

c) gummas

d) regional lymphadenitis

e) encephalitis

f) ophthalmitis

57. The AIDS virus is transmitted by the following mechanisms:

a) aerosol

b) parenteral

c) alimentary

d) transplacental

e) by arthropods

f) air-drop

58. *Epstein-Barr virus* leads to:

a) Kaposi's sarcoma

b) Burkitt's lymphoma

c) congenital injuries

d) liver cancer

e) nasopharyngeal cancer

f) cervical cancer

59. Which claims about the *poliovirus* are FALSE:

a) chronic forms are typical

b) the disease is characterized by flaccid paralysis

c) the cases of asymptomatic forms are greater than the clinically manifested ones

d) the virus is transmitted through sexual contact

e) damages the motor neurons of the spinal cord

f) its isolation is performed on cell cultures

60. Which of the following viruses are DNA:

a) *Influenza virus*

b) *Varicella-zoster virus*

c) *Hepatitis C virus*

d) *Hepatitis B virus*

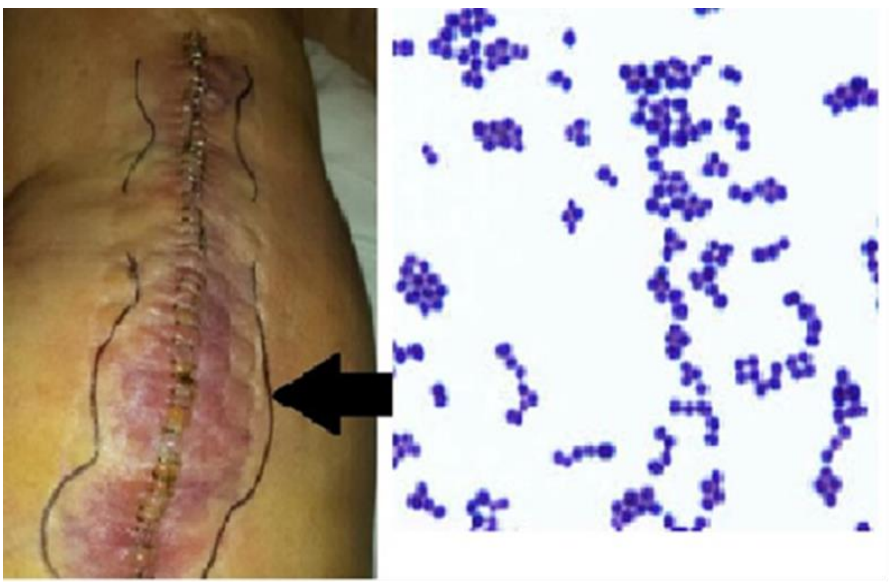
e) *Human Coronavirus*

f) *Rabies virus*

61. CLINICAL CASE 1

After a bone fracture, a 71-year-old man admitted to the Clinic of Orthopedics and Traumatology underwent major surgery to replace his right hip. The patient received intravenous antibiotic prophylaxis in the perioperative period. On the seventh day after the surgery, fever, inflammation and secretion from the wound appeared. Surgical treatment was performed and samples are collected for microbiological examination. After cultivation of the wound secretion on blood agar, growth of colonies with beta hemolysis was observed, and on Levin agar, there was no growth. The microorganism gave a positive catalase and a negative oxidase test.

Which is the most likely causative agent of the infection?



a) *Streptococcus pyogenes*

b) *MRSA*

c) *Escherichia coli*

d) *Pseudomonas aeruginosa*

62. What other tests would you do to confirm the diagnosis?

a) Optochin test

b) IMVUC

c) CAMP test and Bacitracin

d) Plasma coagulase test

63. What is the most appropriate therapy?

a) Penicillin

b) Carbapenems

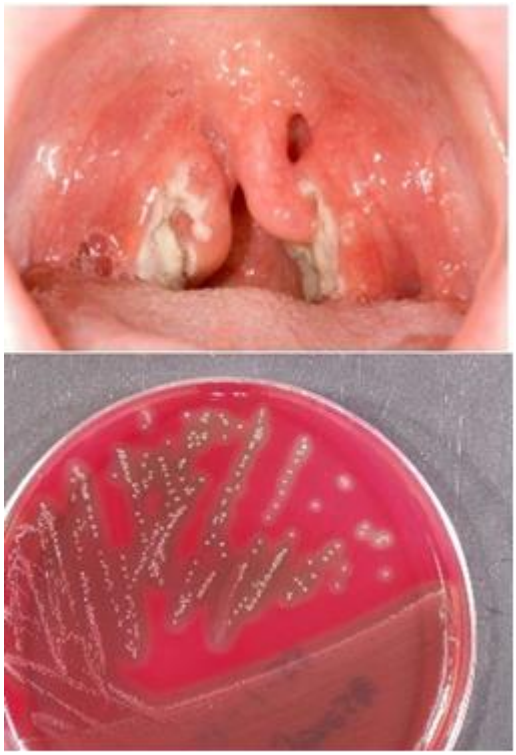
c) Ceftriaxone

d) Glycopeptides

64. CLINICAL CASE 2

A 7-year-old girl was accompanied by her mother to her GP with complaints of fever and pain when swallowing and speaking. Her symptoms started a few days ago, but the symptomatic drugs did not alleviate the complaints. The physical examination showed enlarged tonsils with whitish purulent deposits on them. A throat swab was taken for microbiological examination. 24 hours after cultivation on blood agar, transparent colonies with β-hemolysis, which are catalase-negative, were observed.

What is the most likely causative agent of the infection?



a) *Candida albicans*

b) *Streptococcus pyogenes*

c) *Corynebacterium diphtheriae*

d) *Staphylococcus aureus*

65. What is the most likely diagnosis?

a) Diphtheria

b) Soor

c) Streptococcal angina

d) Staphylococcal throat infection

66. What is the most appropriate therapy?

a) Fluconazole

b) Diphtheria serum

c) Penicillin

d) Vancomycin