

CLINICAL MICROBIOLOGY AND PARASITOLOGY	
GENERAL INFORMATION	
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Assistant/Associate	Assistant Professor Arlen Antolović-Požgain, MD, PhD Assistant Professor Maja Bogdan, MD, PhD Marko Živkov, MD Dinko Paulić, MD Ivana Roksandić Križan, MD
Study Programme	Integrated undergraduate and graduate university study of Medicine
Status of the course	Mandatory
Year of study, semester	4th year, 7th semester
ECTS	2
Workload (hours)	Lectures (20); Seminars (5); Exercise (5)
Expected number of students	70
COURSE DESCRIPTION	
Course objectives	
<p>Get to know, understand and set the indication for microbiological examination in a particular infectious clinical syndrome, independently decide on the time, type and manner of taking biological samples from different organ systems of patients, and require a laboratory-specific microbiological examination. The aim is to train the student and give him the basics that will enable him to connect clinical diagnoses and samples with etiological laboratory diagnostics and synthesis of all methods in microbiological processing of various biological samples and instruct students in routine laboratory processes and other samples. Also, students will learn to interpret the pre-made microbiological finding and test the susceptibility of microorganisms to antimicrobial drugs. At the end of the course, students will be able to independently determine the type of sample and the type of microbiological examination, and interpret the obtained microbiological findings and susceptibility test for the most common infectious clinical syndromes. Also, the goal is to train students theoretically and practically to implement basic measures to prevent and combat nosocomial infections.</p>	
Enrolment requirements and entry competencies	
Completed course: Medical Microbiology and Parasitology in the 3rd year of the university integrated undergraduate and graduate study of medicine	
Learning outcomes at the Programme level	
1.2., 2.1., 2.2., 2.3., 3.1., 3.2., 3.3., 3.4., 3.5., 4.1., 4.2.	
Learning outcomes (5-10)	
<p>After passing the exam, students will acquire basic skills and knowledge in the field of clinical microbiology and will be able to:</p> <ol style="list-style-type: none"> 1. independently set the indication for microbiological examination in a particular infectious clinical syndrome, decide on the time, type and manner of taking biological samples from different organ systems of patients, and require a specific microbiological examination from the laboratory. 2. integrate practical knowledge and skills in the environment of the clinical microbiological laboratory, applying the knowledge and methods used in everyday medical laboratory diagnostics and clinical practice. 	

3. independently take various biological materials, adequate storage and transport of such materials. The student will be able to apply the acquired knowledge and skills in sampling, transport and processing of the most common biological samples.

4. independently make microscopic preparations from biological samples and determine the presence of microorganisms: bacteria, fungi and parasites.

5. critically analyze and interpret the results of diagnostic methods of cultivation of bacteria, viruses, fungi and parasites, as well as serological and molecular diagnostic methods in bacteriology, virology, mycology and parasitology.

6. implement measures to prevent and control healthcare associated infections in teamwork.

All acquired knowledge and skills the student will be able to apply at the analytical level by synthesizing the adopted theoretical foundations and practical methods and procedures.

Course content

Introduction to clinical microbiology

Definition and scope of work of the laboratory for clinical microbiology. Microorganisms - etiological causes of infectious diseases. Diagnostic principles in clinical microbiology. Diagnostic procedures in bacteriology. Diagnostic procedures in virology. Diagnostic procedures in parasitology. Diagnostic procedures in mycology. Sampling of materials for microbiological tests. Direct and indirect diagnostics. Microbiological staining of direct samples. Cultivation and isolation of microorganisms. Serological methods in microbiological diagnostics. Molecular diagnostics.

Antibiotics, disinfection and sterilization

Antimicrobial chemotherapeutics: types, division, mechanisms of action, therapeutic spectrum, testing of bacterial susceptibility to antibiotics, bacterial resistance and mechanisms of resistance. Choice of antibiotics with respect to antibiotic susceptibility testing of bacteria. Antibigram development and the importance of monitoring resistance. Rational pharmacotherapy. Spare antibiotics. Resistant bacteria: MRSA, VISA; VRSA, VRE, PRSP, ESBL, resistant nonfermenters: Pseudomonas aeruginosa and Acinetobacter baumannii, multidrug-resistant bacteria. Disinfection and sterilization: types of disinfectants and mechanism of action, selection of disinfectant. Sterilization procedures: types of sterilization, control of sterilization procedure.

Nosocomial infections

Definition and importance of infections associated with health care - nosocomial, nosocomial infections. Causes of nosocomial infections. BI tanks. Epidemiology BI. Types and divisions of BI. Preventing and combating BI. Systematic control of BI. Control team - prevention and suppression of BI. Prevention measures for the occurrence of BI: hand hygiene, standard protection measures, insulation: contact, reverse. The importance of preventing the spread of resistant bacteria. Bundles of care for the prevention of the most common BI. Control of multidrug-resistant pathogens. Hand hygiene. ("My 5 moments for hand hygiene"). Measures to prevent the spread of resistant bacteria - contact insulation measures. Practical work: Reading antibiogram of outpatient and inpatient pathogens (recognition of MSSA, MRSA, VRE, ESBL, multidrug-resistant Pseudomonas and Acinetobacter. Analysis of hospital epidemic. Carrying out hand hygiene according to five indications in six steps.

Fundamentals of molecular microbiology

Introduction to molecular microbiology. Diagnostic principles and procedures in molecular microbiology. Nucleic acid amplification. Molecular microbiology in the diagnosis of etiological agents of infectious diseases: application in clinical microbiological diagnostics. Molecular microbiology techniques in pathogen diagnosis and typing: in situ hybridization, polymerase chain reaction (PCR), RT-PCR, real time PCR, multiplex PCR, DNA microarray. Practical application of molecular diagnostics in bacteriology and virology. Detection of antimicrobial resistance and molecular epidemiology.

Diagnosis of urogenital and other sexually transmitted infections

Urogenital infection. Etiology and epidemiology of urogenital and sexually transmitted infections. Causes of sexually transmitted diseases: *Neisseria gonorrhoeae*, *Treponema pallidum*, Chlamydia, Mycoplasma and Ureaplasma. Viruses and parasites that cause urogenital infections. Samples for the diagnosis of urogenital and sexually transmitted infections. Diagnostic procedures and methods for diagnosing urogenital tract infections. Microbiological treatment of urine - method, results, clinical interpretation and diagnostic criteria.

Serological tests in clinical diagnostics (bacteriology + virology)

Basic principles of serological reactions. Serology - definitions: serum sera, antibody titer and titer dynamics. Seroconversion. Serological tests in bacteriology: tests by Widal, Weil-Felix, Wright, agglutination, immunoenzymatic tests, indirect immunofluorescence, western blot. Serological detection of spirochete infection (*Treponema*, *Borrelia*, *Leptospira*). Application of serology in the diagnosis of viral infections. Diagnosis of hepatitis, HIV, Hepatitis virus and respiratory viruses. Serological tests: agglutination, complement fixation test (CFR), neutralization test (NT), Mason's and Paul-Bunell test., Enzyme-linked immunosorbent assay (EIA, ELISA), indirect immunofluorescence (IFA), Western-Blot (WB) - RIBA and test immunoperoxidases, etc. Application of serology in the diagnosis of parasites and fungi.

Diagnosis of bacterial infections of the respiratory system (including tuberculosis)

Characteristics and division of respiratory infections. Epidemiology and etiology of respiratory tract infections. Microorganisms causing respiratory infections. Atypical bacteria. Causes from the respiratory tract. Direct and indirect diagnosis of the cause of respiratory tract infections. The role of clinical microbiology and rational antimicrobial pharmacotherapy. Nosocomial respiratory infections: pneumonia associated with ventilation. Tuberculosis - *Mycobacterium tuberculosis* - diagnostics and significance. Epidemiology of tuberculosis. Mycobacterial resistance to antitubercotics. Tuberculosis treatment, prevention and control.

Diagnosis of bacterial infections of the gastrointestinal tract. H.pylori

Normal flora of the digestive tract and the role of the intestinal flora. Characteristics and division of gastrointestinal infections. Epidemiology and etiology of gastrointestinal tract infections.

Pathogenesis and pathophysiology of gastrointestinal tract infections. Microorganisms causing infections of the digestive system. Bacterial causes of GIT infections: *Salmonella*, *Shigella*, *Yersinia*, *Campylobacter*, *Vibrio cholerae*. Causes for microbiological diagnosis of gastrointestinal tract infections. Microbiological diagnosis of gastrointestinal tract infections. Identification of the most common causes of GIT infections. Microbiological treatment of stool. Differential and selective nutrient media. *Salmonella* serotyping. *H. pylori*

- laboratory diagnostic. Treatment of GIT infections. Presentation and discussion of clinical cases of gastrointestinal infections.

Diagnosis of bacterial CNS infections. Diagnosis of bacteremia and endocarditis

Etiology and epidemiology of central nervous system infections. Pathophysiology of CNS infection. Clinical presentation of CNS infections. Bacterial meningitis and meningoencephalitis. Bacterial causes of CNS infections: *Neisseria meningitidis*, BHS-B, *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Listeria monocytogenes*, *Escherichia coli* K1, Laboratory diagnosis of CNS infections: samples and sample processing. Biochemical and microbiological treatment of cerebrospinal fluid. Direct microscopic preparation from cerebrospinal fluid. Treatment and prevention of CNS infections. Vaccines. Bacteremia and sepsis: definitions, etiology, pathophysiology and laboratory diagnostics. Blood sampling for the diagnosis of invasive bacterial infections. Blood cultures - microbiological processing, clinical interpretation and significance of blood cultures. Infectious endocarditis: definition, etiology, pathophysiology and microbiological diagnosis. Treatment of invasive bacterial infections. Presentation and analysis of clinical cases of meningitis, sepsis and infectious endocarditis.

Diagnosis of infections in immunocompromised patients. Fungal infections

Etiology of infections in immunocompromised patients. Opportunistic pathogens. Laboratory diagnosis of infections in immunocompromised patients. Fungal infections - etiology, pathophysiology and microbiological diagnosis. Mycoses and mycotoxicosis. Systemic and disseminated fungal infections. Breeding and identification of yeasts and molds. Samples for the diagnosis of fungal infections. Yeasts and prey causes fungal infections: *Candida*, *Aspergillus*, *Cryptococcus*, dermatophytes. Antifungals and treatment of fungal infections.

Diagnosis of parasitic infections

Unicellular and multicellular parasites cause parasitic infections. Laboratory diagnosis of intestinal parasites. Laboratory diagnosis of blood and tissue parasites. Direct and indirect diagnosis of parasites. Life cycle, epidemiology, laboratory diagnostics, treatment and prevention of blood and tissue protists: *Trypanosoma* spp., *Leishmania* spp. Genus *Plasmodium* (*P. malariae*, *P. vivax*, *P. ovale* and *P. falciparum*), filariasis; *Toxoplasma gondii* serological diagnosis of toxoplasmosis. Arthropods - vectors for the transmission of blood and tissue protists. Life cycle, epidemiology, laboratory diagnostics of digestive and genitourinary system protists: *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*, *Trichomonas vaginalis*. life cycle, epidemiology, laboratory diagnosis of roundworms: *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Strongyloides stercoralis*, *Enterobius vermicularis*, *Trichinella spiralis* - MIFC for stool egg finding, perianal imprint, coproculture, coproculture, three. Serological diagnosis. Life cycle, epidemiology, laboratory diagnostics of flatworms: *Taenia* spp., *Echinococcus granulosus*, *Hymenolepis nana*, *Fasciola hepatica*, *Shistosoma* spp. - MIFC from stool, serological methods for the diagnosis of echinococcosis.

Laboratory diagnosis of viral diseases

Laboratory diagnostics of viral diseases: samples, direct virus detection, isolation, molecular diagnostics, serology. Cultivation of the virus in cell culture, on a fertilized hen's egg and in an experimental animal. Preparation of cell cultures - primary and continuous cell cultures, diploid stem cultures. Cytopathic effects of the virus in cell culture. Viral inclusions. Taking clinical material for virological tests. Rapid tests for the detection of virus antigens in a clinical sample - latex and immunochromatogenic tests. Viral vaccines - types, production and application. Antiviral drugs: chemoprophylaxis and chemotherapy of viral diseases, highly effective antiretroviral therapy (HAART).

Respiratory infections caused by viruses. Infectious mononucleosis. TORCH

Respiratory tract viral infections: characteristics and division of viral infections respiratory system. Epidemiology and etiology of respiratory tract viral infections. Agents from the respiratory tract. Direct and indirect diagnosis of viral causes of respiratory tract infections. Respiratory viruses causing respiratory infections: pathogenesis, epidemiology, clinical syndromes, laboratory diagnostics, treatment, prevention and control of adenovirus, orthomyxovirus, paramyxovirus, coronavirus. Influenza virus - "shift" and "drift". Pandemics and flu epidemics. SARS virus. Respiratory syncytial virus and human metapneumovirus. Measles virus. Mumps virus. Other viruses cause respiratory diseases. Pathogenesis, epidemiology, clinical syndromes, laboratory diagnostics, treatment, prevention and control of viruses that cause congenital infections: *Togaviridae* (*Rubivirus*), *Parvoviridae* (parvovirus B-19), *Hepresviridae*, hepatitis viruses and HIV. TORCH - serological testing of pregnant women. Pathogenesis, epidemiology, clinical syndromes, laboratory diagnostics, treatment, prevention and control of *Herpesviridae* viruses: herpes simplex virus (VHS), varicella zoster virus (VZV), Epstein-Barr virus (EBV), Cytomegalovirus (CMV), human herpes virus 6,7,8 (XXV-6, XXV-7 and XXV-8). Infectious mononucleosis syndrome - etiology, samples and laboratory diagnostics.

CNS viral infections. Rabies. Blood-borne viruses

Viruses cause infections of the central nervous system. Viral tropism for CNS. Primary and secondary tropism. Clinical characteristics, samples, laboratory diagnostics, treatment and prevention of viral causes of CNS infections: tick-borne meningoencephalitis virus, lymphocytic choriomeningitis virus, hepesviruses, paramyxoviruses, picornaviruses, arboviruses (alphaviruses, bunyviruses, flavi. Virus rabies and rabies - epidemiology, pathogenesis, laboratory diagnosis, treatment and prevention. Blood-borne viruses: hepatitis viruses and retroviruses (HIV, HTLV) - epidemiology, pathogenesis, laboratory diagnosis, treatment and prevention.

Viral infections of the digestive system

Digestive viruses and viral gastroenteritis - structure, replication, pathogenesis, epidemiology, clinical syndromes, laboratory diagnosis, treatment, prevention and control of viruses causing gastrointestinal infections: rotavirus, adenoviruses, astroviruses, caliciviruses - norovirus. Viruses that enter the body's digestive system: picornaviruses. Significance of viral infections of the digestive system. Methods of rapid microbiological diagnosis of gastroenteritis virus. Review and analysis of a clinical case of viral gastroenteritis.

Taking and processing of clinical samples

Sampling of clinical specimens for microbiological examinations. Samples from: respiratory system, genital system, samples from urinary system, from digestive system, blood samples for blood culture, cerebrospinal fluid samples, other body fluids, abscesses, wounds, burns and exudates, ear and eye samples, bone samples, intravenous catheter , samples for serological and virological tests. Priority samples. Transport and labeling of samples. sampling time and storage of samples. Sample rejection criterion. Microbiological germination of individual samples depending on the sampling site. Samples for anaerobic treatment. Practical work: Sampling of respiratory samples. Microbiological treatment of primarily sterile and priority samples. Implantation of a urine sample and description of the sample from the respiratory tract, urinary system and interpretation of selected samples from the routine.

Clinical interpretation of selected samples (cerebrospinal fluid, blood cultures, BAL, PBS, urine, swabs)

The role of microbiological laboratory methods in the etiological diagnosis of infectious diseases. Significance and interpretation of antimicrobial chemotherapy susceptibility test results in targeted infection therapy. Practical part: Clinical interpretation of microbiological findings and significance of microbiological test results in the treatment of infectious diseases with special reference to priority samples and causes from sterile or minimally contaminated samples. Interpretation of the most common samples in the clinical microbiological laboratory (urine and swabs).

Microscopy of direct samples

Microbiological processing of priority samples: cerebrospinal fluid, blood cultures, invasive samples from the respiratory tract and biopic samples. Staining, microscopy, and the importance of detecting bacteria in primarily sterile samples. Practical part: Microscopy of direct samples: samples of cerebrospinal fluid, blood cultures and aspirates of the trachea and Gram stained bronchoalveolar lavage from the collection of preparations collected from routine.

Work in the hospital infection control team

Mode of teaching

Lectures; Seminars; Exercises

Student obligations

Attendance at all forms of classes is mandatory, and the student must access all knowledge tests. A student may justifiably miss 30% of each form of instruction. Unfinished exercise must be colloquial.

Monitoring student work (alignment of learning outcomes, teaching methods and grading)

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Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Grade points	
					Min.	Max.
Class attendance	0,1	1-6	Attendance in class	Records	3	5
Practical work (exercises)	0,1	1-6	Studying for the practical exam and class attendance	Assignments making	1	5
Seminar paper	0,4	1-6	Preparation of seminar paper	Presentation of seminar paper	1	20
Written exam	1	1-6	Continuous studying during classes	Written exam	20	50
Oral exam	0,4	1-6	Continuous studying during classes	Oral exam	1	20
Total	2					100

Student work is evaluated during classes and at the final exam. Students are graded descriptively - passed or failed. During the tour, the student will be able to collect a maximum of 100 points. Students can have a maximum of 30 points during their classes through various forms of activities (see Table 1) and a maximum of 70 points in the final exam. The final part of the exam consists of a written and an oral part. The student needs to pass more than 60% on the written part of the exam in order to be able to access the oral part of the exam. The final grade is the sum of grade points achieved during classes and at the final exam.

Table 1. Evaluation of student teaching obligations

	EVALUATION	MAX. NUMBER OF POINTS
Practical work/laboratory exercises	Active participation	5
	Total	5
Seminar	Active participation	2 0
	Total	2 0
Lectures	Attendance	5
	Total	5
	TOTAL	3 0
Final exam	Written part	5 0

	Oral part	2 0
	Total	7 0
TOTAL	Active participation	100

Class attendance

The student must attend a minimum of 70% of all forms of teaching: exercises, seminars and lectures and access all forms of knowledge testing. A student who misses seminars and / or exercises more than 30% of classes up to a total of 50% of all forms of classes must make up for missed material by colloquium.

Practical work (exercises)

The evaluation of the student's practical work is assessed at each exercise. The student can achieve a maximum of 5 points in total during 5 hours of active participation.

Seminars

During the course, the student can collect a maximum of 20 grade points through active preparation and presentation of seminars, which is mandatory according to the following criteria:

1-5 grade points: the answer meets the minimum criteria

6-10 grade points: average answer with noticeable errors

11-15 points: very good answer with slight errors

16-20 rating points: exceptional answer

Lectures

By attending lectures, a student can achieve 3-5 grade points according to the following scheme: participation in 70-79.99% of lectures is evaluated with 3 grade points, 80-89.99% 4 grade points, 90-100% 5 grade points.

Final exam

A student who has duly completed all forms of teaching has acquired the right to sign and take the final exam. The final exam is mandatory and consists of a written and an oral part. During the final exam, the student can receive a maximum of 70 points, of which 50 points in the written part and 20 in the oral part.

The written part of the final exam consists of 50 questions with five answers offered, of which only one is correct. The minimum criterion for gaining grade points is 60% of correctly resolved questions. Points earned in the written part of the final exam are converted into grade points according to the criteria listed in Table 2. Points earned in the final exam are added to the points earned during classes. In case the student does not meet the minimum criteria in the final exam in the first exam term, he / she takes the final exam again in the next exam term, as well as in case he / she does not meet in the oral part of the exam.

Table 2. Evaluation of the written part of the final exam

Percentage of correctly solved tasks (%)	Grade points
60,00-69,99	20
70,00-74,99	25

75,00-79,99	30
80-84,99	35
85-89,99	40
90,00-94,99	45
95-100	50

The oral part of the exam consists of one question from the field of clinical microbiology.

Evaluation of the oral part of the final exam:

1 – 5 grade points: the answer meets the minimum criteria

6 - 10 grade points: average answer with noticeable errors

11 – 15 grade points: very good answer with slight errors

16 - 20 grade points: exceptional answer

Formulation of the final grade

Grades earned in the final exam are added to the points earned during the course.

Assessment in the ECTS system is performed by absolute distribution, ie on the basis of final achievement and is compared with the numerical system as follows:

A - excellent (5): 90-100 grade points

B - very good (4): 80-89.99 grade points

C - good (3): 70-79.99 grade points

D - sufficient (2): 60-69.99 grade points

E - sufficient (2): 50-59.99 grade points

Required reading (available in the library and through other media)

	Number of copies in the library	Availability through other media
1. KLINIČKA MIKROBIOLOGIJA“, urednice: Nataša Beader, Branka Bedenić, Ana Budimir. Medicinska naklada, Zagreb: 2019.	13	

Additional reading

1. Kalenić, S. i suradnici: Medicinska mikrobiologija, drugo, izmijenjeno i obnovljeno izdanje, Medicinska naklada, Zagreb: 2019.

2. Damani N.: Priručnik o prevenciji i kontroli infekcija, 4. izdanje; Zagreb, Medicinska naklada, 2019.

Course evaluation procedures

The quality and success of the course is monitored through an anonymous student survey that will include assessment of students on the quality of various forms of teaching in the course and on teachers conducted by the Department of Microbiology and Parasitology, Faculty of Medicine Osijek. Also, the output knowledge will be monitored through the success of the students at the end of the

course. During the classes, records of student attendance at lectures, seminars and exercises will be used.

In addition to the above, the quality of the teaching process is also monitored by conducting a unique university survey among students for teacher evaluation determined by the Senate of the J. J. Strossmayer University in Osijek.

Note /Other

E-learning is not included in the norm of subject hours, but it is used in teaching and contains links to various pages, video and audio materials available on the website.