

MEDICAL MICROBIOLOGY WITH LABORATORY TECHNOLOGIES II	
GENERAL INFORMATIONS	
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Assistant/Associate	Asst. Prof. Arlen Antolović-Požgain, MD, PhD Asst Prof. Maja Bogdan, MD, PhD Maja Tomić-Paradžik, MD, PhD Marijan Orlović, MD Marko Živkov, MD Ivana Roksandić-Križan, MD Sara Kibel, MD Dinko Paulić, MD
Study Programme	University Undergraduate Study of Medical Laboratory Diagnostics
Status of the course	mandatory
Year of study, semester	3 rd year, 6 th semestar
ECTS	4
Workload (hours)	Lectures: 30; seminars: 15; laboratory exercises: 15
Expected number of students	30-35
COURSE DESCRIPTION	
Course objectives	
The student will learn about their effect on the human body, methods of etiological diagnosis, prevention and therapy. One of the goals is for students to learn the basic groups of antifungal and antiparasitic drugs from the point of view of spectrum of action, mechanism of action and mechanism of resistance. The aim of the course is also to acquire prior knowledge of diagnostic procedures in parasitology and mycology, namely: direct diagnosis, cultivation, serological diagnosis, molecular diagnosis, as well as rapid diagnostic procedures.	
Enrolment requirements and entry competencies	
No additional conditions	
Learning outcomes at the Programme level	
1.1, 1.2, 2.1, 2.2, 2.3, 2.6, 3.1	
Learning outcomes	
After completing lectures, seminars and exercises, independent study and passing the exam, students will be able to: <ol style="list-style-type: none"> 1. use acquired knowledge for work in a parasitological and mycological laboratory, hygiene procedures in laboratories, familiarization with specific laboratory instruments and specifics in the diagnosis of parasitosis and mycosis. 2. independently perform tests in the mycological laboratory: cultivation of mushrooms, substrates, preparation and examination of microscopic preparations from cultures of yeasts and molds. 3. independently make microscopic preparations from biological samples and determine the presence of parasites at any stage of the life cycle. 4. distinguish between hematophagous arthropods - vectors of certain types of parasites as well as other ectoparasites and vectors of other diseases belonging to arthropods. 5. critically evaluate modern knowledge about the most important pathogenic fungi and parasites in medicine, the causative agents of human infections, and the most important diagnostic procedures in mycology and parasitology. 	
Course content	
Lectures: L1: General mycology: shape, structure and reproduction of fungi; pathogenesis of fungal diseases	

Shape, structure and reproduction of mushrooms. Yeasts and molds. Metabolism and physiology of fungi. Classification and taxonomy of medicinally important fungi. Resistance of fungi to physical and chemical factors. Fungal antigens and fungal vaccines. Pathogenesis of fungal diseases: virulence factors of fungi and human defense mechanisms. Fungal diseases. Cutaneous mycoses. Systemic mycoses. Opportunistic mycoses. Mycotoxicosis. Antimycotics.

L2: Laboratory diagnostics of fungal diseases

Laboratory diagnostics of fungal diseases. Taking, sending and storing the sample in case of suspected diseases caused by fungi. Direct detection of fungi from patient material. Indirect proof of the causative agent from samples from patient material. Cultivation of mushrooms on nutrient media and mushroom identification. Serological diagnosis of fungal diseases. Testing the sensitivity of fungi to antimycotics.

L3: Special medical mycology: phylum *Ascomycota*

Classification of ascomycotes. Opportunistic infections caused by fungi from the phylum *Ascomycota*. Infectious fungal diseases caused by ascomycota. Genus *Candida*: cultivation, identification, laboratory diagnostics and treatment of infections caused by candida. Genus *Aspergillus*: cultivation, identification, laboratory diagnosis and treatment of infections. *Pneumocystis jirovecii*: cultivation, identification, laboratory diagnosis and treatment of infections caused by pneumocystis. Causative agents of dermatophytoses: clinical pictures, breeding, identification, laboratory diagnosis and treatment of dermatophytoses. Dimorphic primary pathogenic fungi: *Histoplasma*, *Coccidioides*, *Blastomyces*.

L4: Special medical mycology: phylum *Basidiomycota* and phylum *Zygomycota*

Phylum *Basidiomycota*: genus *Cryptococcus*, genus *Malassezia* - cultivation, identification, laboratory diagnostics and treatment of infections. The phylum *Zygomycota*: genus *Rhizopus* and genus *Mucor* - cultivation, identification, laboratory diagnosis and treatment of zygomycosis.

L5: General medical parasitology

Parasitism as an ecological and medical concept - definitions and basic terms. Biological associations. Parasites - agents and transmitters of diseases, epidemiological terms. Classification and nomenclature of medically important parasites. Pathogenicity of parasites. Fundamentals of laboratory diagnostics of parasitosis: samples and sampling. Methods of direct proof of parasites. Methods of indirect proof of parasites. Serological methods in proving parasitosis.

L6: Blood-tissue protists

Structure and biological properties, epidemiology, clinical picture, laboratory diagnostics and treatment of blood-tissue protists: genus *Leishmania*, genus *Trypanosoma*, genus *Toxoplasma*, genus *Plasmodium*.

L7: Protists of the digestive system and genitourinary system

Structure and biological properties, epidemiology, clinical picture, laboratory diagnostics and treatment of protists of the digestive system: genus *Entamoeba* (*E. histolytica* and other amoebae; opportunistic amoebae); genus *Giardia* (*G. lamblia*); *Coccidia*: genera *Cryptosporidium*, *Cyclospora* and *Isospora*. Content: Structure and biological properties, epidemiology, clinical picture and laboratory diagnostics of genitourinary protists: genus *Trichomonas*.

L8: Intestinal nematodes

Structure and biological properties, epidemiology, clinical picture, laboratory diagnostics and treatment of intestinal nematodes: genus *Ascaris*, genus *Trichuris*, genus *Enterobius*, genus *Ancylostoma*, genus *Strongyloides*.

L9: Tissue nematodes

Structure and biological properties, epidemiology, clinical picture, laboratory diagnosis and treatment of tissue nematodes: genus *Trichinella*, genus *Toxocara*, genus *Anisakis*, Natural invasions by nematode larvae: larva migrans visceralis and cutanea. Filariae and related tissue nematodes (*Wuchereria bancrofti*, *Brugia malayi*, *Loa loa*, *Onchocerca volvulus*, genus *Dirofilaria*, genus *Mansonella*, genus *Dracunculus*).

L10: Phylum *Platyhelminthes*: class *Cestoidea* (tapeworms)

Structure and biological properties, epidemiology, clinical picture, laboratory diagnostics and treatment of tapeworms: genus *Taenia*, genus *Hymenolepis*, genus *Diphyllobothrium*, genus *Echinococcus*. Intestinal and tissue tapeworms.

L11: Phylum *Platyhelminthes*: class *Trematoda* (flukes)

Structure and biological properties, epidemiology, clinical picture, laboratory diagnosis and treatment of flukes: liver flukes - genus *Fasciola*, genus *Dicrocoelium*, genera *Opisthorchis* and *Clonorchis*; blood

flukes: genus *Schistosoma*. Intestinal flukes: genus *Fasciolopsis* and other intestinal flukes; lung flukes: genus *Paragonimus*

L12: Medically important arthropods: phylum Arthropoda

Medical arachnoentomology. Classification of arthropods. Arthropods of medical importance: class *Eucrusea*, class *Chilopoda*, class *Arachnida*, class *Insecta*.

Seminars:

S1: Medically important yeasts and molds

Cultivation and identification of medicinally important mushrooms. Yeasts and molds. Medically significant endogenous (opportunistic) and exogenous yeasts; medically significant dermatophyte and non-dermatophyte (opportunistic) molds; primarily pathogenic dimorphic fungi. Laboratory diagnostics of fungal diseases - breeding characteristics, growing media and identification. Antifungals.

S2: 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. Systemic and disseminated fungal infections. Cultivation and identification of yeasts and molds. Samples for the diagnosis of fungal infections. Yeasts and molds causing fungal infections: *Candida*, *Aspergillus*, *Cryptococcus*. Antimycotics and treatment of fungal infections.

S3: Methods of parasitological laboratory diagnostics

Methods of direct evidence of the causative agent: examination of the stool, examination microscopes, methods of accumulation or concentration, anal and perianal impression, other causes of material from the intestine; urethral and vaginal discharge, tests of urine, sputum and sputum, tests of biptic materials and punctures. Blood tests: preparation and staining of blood preparations. Methods of indirect proof of the causative agent: biological experiment and xenodiagnostics, cultivation on nutrient media. Immunoreactions - serological tests in proving parasitic diseases.

S4: Protists of blood and tissues.

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*), filariae; *Toxoplasma gondii* - serological diagnosis of toxoplasmosis. Arthropods – vectors for the transfer of blood and tissue protists.

S5: Protists of the digestive and genitourinary systems.

Life cycle, epidemiology, laboratory diagnostics of protists of the digestive and genitourinary systems: *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*, *Trichomonas vaginalis*. Peculiarities of laboratory diagnostics of protists of the digestive and genitourinary systems.

S6: Roundworms

Life cycle, epidemiology, laboratory diagnostics of roundworms: *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Strongyloides stercoralis*, *Enterobius vermicularis*, *Trichinella spiralis* - MIFC for finding eggs from stool, perianal impression, coproculture, trichineloscopy. Serological diagnosis.

S7: Flatworms

Life cycle, epidemiology, laboratory diagnosis of flatworms: *Taenia* spp., *Echinococcus granulosus*, *Hymenolepis nana*, *Fasciola hepatica*, *Schistosoma* spp. - MIFC from stool, serological methods for diagnosis of echinococcosis.

Practices:

P1: Medically important fungi I: Cultivation and identification of yeasts. *Pneumocystis jirovecii*.

Cultivation and identification of yeasts. Structure of yeast. Fermentation and assimilation test. Genus *Candida*: *C. albicans* and *Candida* spp., clinical samples, sensitivity to antifungals. Genus *Cryptococcus* – *C. neoformans*: laboratory diagnostics and clinical samples. Identification of *P. jirovecii*. *Pneumocystis jirovecii* - laboratory diagnostics (preparation, DFA, PCR) Practical work: Description of colonies of *Candida albicans*, *Candida krusei*, *Geotrichum* spp. grown on Sabouraud's agar. Microscopy of native preparations of yeasts. Microscopy of a microscopic preparation of yeasts stained by Gram. Microscopy of the *C. albicans* germination test. Description of *Cryptococcus* colonies on a solid substrate, microscopy of cryptococcal preparation, cryptococcal ink preparation. Microscopy of *P.*

jirovecii preparations.

P2: Medicinally important fungi II: Cultivation and identification of molds.

Mold cultivation and identification. Mold structure. *Penicillium*, *Aspergillus*, *Mucor*, *Rhizopus* – clinical samples, sample-dependent interpretation of mold isolates, antifungal susceptibility testing. Serodiagnosis of systemic mycoses. Practical work: Description of *Aspergillus*, *Mucor* and *Penicillium* colonies on Sabouraud's agar. Microscopy of preparations with lactophenol *Aspergillus*, *Mucor* and *Penicillium*.

P3: Blood and tissue protists I.

Trypanosoma spp. - life cycle, epidemiology, laboratory diagnostics: blood smear and thick drop stained according to the Giemsa-Romanowski (GR) method. *Toxoplasma gondii* – epidemiology, life cycle, prevention and treatment, lab. diagnostic. Practical part: Microscopy of *Trypanosoma* spp. preparations from blood smear stained by GR. Microscopy of *T. gondii* preparations stained according to GR. Serological diagnosis of toxoplasmosis. *Leishmania* spp. - diagnosis of leishmaniasis - direct preparation of bone marrow stained with GR. Cultivation (NNN agar), microscopy of preparations according to GR *Leishmania* spp.

P4: Blood and tissue protists II. Genus Plasmodium. Microfilariae.

Genus *Plasmodium*: life cycle, epidemiology, clinical disease, laboratory diagnosis, treatment, prevention and control of malaria. *P. malariae*, *P. vivax*, *P. ovale* and *P. falciparum*. Filariae - life cycle, epidemiology, clinical picture, laboratory diagnostics. Practical work: microscopy of blood smears and thick drops stained according to Giemsa-Romanowski and identification of developmental and diagnostic forms of species of the genus *Plasmodium*. Microscopy of microfilariae from Giemsa-Romanowski stained blood smear.

P5: Protists of the digestive and genitourinary systems.

Life cycle, epidemiology, laboratory diagnostics of protists of the digestive and genitourinary systems: *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*, *Trichomonas vaginalis*. Practical work: Microscopy of stool preparations and secretions of the genitourinary system, MIFC method for finding cysts: *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium parvum*, *Trichomonas vaginalis*. Cultivation of protists. *Entamoeba moshkowskii* – representation of amoeboid movement. Other protists in the digestive system - microscopy of preparations (MIFC): *Entamoeba coli*, *Blastocystis hominis*, *Iodamoeba butschlii*.

P6: Identification of eggs, larvae and adult roundworms.

Life cycle, epidemiology, laboratory diagnostics of roundworms: *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Strongyloides stercoralis*, *Enterobius vermicularis*, *Trichinella spiralis* - MIFC for finding eggs from stool, perianal impression, coproculture, trichinostomy, identification of adults, larvae and eggs of roundworms. Serological diagnosis. Practical part: microscopy of stool preparations (MIFC): *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Strongyloides stercoralis*; *Enterobius vermicularis* – microsporing of the perianal impression according to Graham; *Trichinella spiralis* - microscopy of meat preparations infected with trichinella larvae. Identification of adult parasites from the collection of permanent preparations.

P7: Identification of eggs, larvae and adult flatworms.

Life cycle, epidemiology, laboratory diagnostics of flatworms: *Taenia* spp., *Echinococcus granulosus*, *Hymenolepis nana*, *Fasciola hepatica*, *Schistosoma* spp. - MIFC from stool, serological methods for diagnosis of echinococcosis, identification of adults, larvae and eggs of roundworms. Practical part: microscopy of stool preparations (MIFC): *Taenia* spp, *Fasciola hepatica*, *Shistosoma* spp. Microscopy of a native preparation from the contents of a hydatid cyst (*Echinoocccus granulosus*). Identification of adult parasites from the collection of permanent preparations.

Mode of teaching

Lectures, seminars and laboratory exercises.

Student obligations

Attending all forms of classes is mandatory, and the student must pass all knowledge tests. A student can excuse himself from 30% of all classes. Unexcused absences, as well as absences outside the percentage of excused absences, must be compensated by colloquium.

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

Exam method: written exam.

Teaching activity	ECTS	Learning outcomes	Student activity	Assessment methods	Grade points	
					Min.	Max.
Class attendance (lectures, seminars, exercises)	0.2	1-5	Attendance in class and active participation	Records	3	5
Seminar paper	0.4	1-5	Preparation of seminar paper	Presentation of seminar paper	1	10
Practical work (exercises)	0.6	1-5	Studying for the practical exam and class attendance	Practical examination	6	15
Final exam	2.8	1-5	Continuous studying during classes	Written exam	16	70
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Evaluation of the obligations of students

Attending classes

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

Students' work is evaluated during classes and on the final exam. Students are evaluated numerically and descriptively: insufficient (1), sufficient (2), good (3), very good (4), excellent (5). During the course, the student will be able to collect a maximum of 100 grade points. Students can obtain a maximum of 30 points during classes through different forms of activities (see Table 1) and a maximum of 70 points on the final exam. The student must achieve more than 60% on the written part of the exam. The final grade represents the sum of the grade points achieved during the class and on the final exam.

Practical work (exercises):

Final colloquium - the practical part of the exam consists of three practical tasks that include microscopy of preparations (5 pieces) from parasitology (3 pieces) and mycology (2 pieces), culture identification on nutrient agar and identification of adult parasites from the collection of permanent preparations. The student must achieve at least 60% on the practical part of the exam to be able to take the final exam. Students can obtain a maximum of 15 grade points on the practical exam (see Table 2), depending on the percentage of correctly solved tasks. The final colloquium is organized after the end of classes and within each exam period as a practical part of the exam.

Evaluation of the final colloquium - practical exam

Percentage of correctly solved	Number of correct answers	Grade points (15)
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tasks (%)	(X/16)	
60,00 - 69,99	10	6
70,00 – 74,99	11	8
75,00 – 79,99	12	9
80,00 – 84,99	13	11
85,00 - 89,99	14	13
90,00 – 94,99	15	14
95,00 – 100,00	16	15

Seminars: During classes, the student can collect a maximum of 10 grade points by actively preparing and presenting the seminar, which is mandatory according to the following criteria:

1-2 grade points: the seminar meets the minimum criteria; 3-5 grade points: average answer with noticeable errors; 6-8 grade points: very good answer with minor errors; 9-10 grade 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 properly completed all forms of teaching has acquired the right to signature and participation in final exam. The final exam is mandatory and consists of a written part. During the final exam, a student can receive a maximum of 70 grade points.

The written part of the final exam consists of 70 questions with five possible answers, of which only one is correct. The minimum criterion for obtaining grade points is 60% of correctly solved questions. The points obtained on the written part of the final exam are converted into grade points according to the criteria listed in Table 3. The points obtained on the final exam are added to the points obtained during classes. If student does not meet the minimum criteria on the final exam in the first exam period, he/she takes the final exam again in the next exam period.

Evaluation of the written part of the final exam

Percentage of correctly solved tasks (%)	Number of correct answers (X/70)	Grade points (70)
60,00 - 60,99	42	16
61,00 – 61,99	43	18
62,00 – 63,99	44	20
64,00 - 64,99	45	22
65,00 – 66,99	46	24
67,00 – 67,99	47	27
68,00 – 69,99	48	30
70,00 – 70,99	49	32
71,00 – 71,99	50	34
72,00 – 73,99	51	36
74,00 – 74,99	52	38
75,00 – 76,99	53	40
77,00 – 77,99	54	43
78,00 - 79,99	55	46
80,00 – 80,99	56	48

81,00 – 81,99	57	50
82,00 – 83,99	58	52
84,00 – 84,99	59	54
85,00 – 86,99	60	56
87,00 – 87,99	61	59
88,00 – 89,99	62	62
90,00 – 90,99	63	66
91,00 – 91,99	64	67
92,00 – 93,99	65	68
94,00 – 94,99	66	69
95,00 – 100,00	67-70	70

Formulation of the final grade:

The grade points obtained during the class are joined by the points obtained on the final exam. Grading is done by absolute distribution, i.e. based on the final achievement and is compared with the numerical system as follows:

A — excellent (5): 80-100 grade points; B — very good (4): 70-79.99 grade points; C — good (3): 60-69.99 grade points; D— sufficient (2): 50-59.99 grade points

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

Title	Number of copies in the library	Availability through other media
Kalenić i sur. Medicinska mikrobiologija. Drugo, izmijenjeno i obnovljeno izdanje. Medicinska naklada, Zagreb, 2019. (udžbenik) - odabrana poglavlja		

Additional reading

Jawetz, Melnick, & Adelberg's Medical Microbiology, 25th edition. Brooks GF, Carroll KC, Butel JS, Morse SA, Mietzner TA editors. Lange Medical Books/McGraw-Hill: New York, Chicago, San Francisco, Lisboa, London, Madrid, Mexico City, Milan, New Delhi, San Juan, Seoul, Singapore, Sydney, Toronto, 2019

Course evaluation procedures

Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality improvement office of the Faculty of Medicine Osijek.