



INSTITUTO DE HIGIENE E  
**MEDICINA TROPICAL**  
DESDE 1902

## LEPTOSPIROSIS AND LYME BORRELIOSIS: RE-EMERGING DISEASES IN THE GLOBAL WORLD

### *Curricular Unit characterization*

#### *Curricular Unit name:*

“Leptospirosis and Lyme Borreliosis: Re-emerging Diseases in the Global World” (LLB: RDGW)

#### *Scientific area acronym:*

Zoonotic Spirochetes (LeptoBor)

#### *Duration:*

Optional Module (2nd Semester) - 26 May to 11 June 2025

#### *Working hours:*

168 hours

#### *Contact hours:*

42 hours

#### *ECTS:*

6

#### *Observations:*

The CU has a significant laboratory component (around 57%) between laboratory and theoretical-practical classes. Some classes are co-teaching.

### *Teacher in charge and respective teaching load in the Curricular Unit:*

- Maria Luísa Vieira (Principal Researcher): **34 hours** (6h L; 8h TP; 14h LP; 2,5h S; 1,5h T; 2h Exam);

### *Other teachers and respective teaching load in the Curricular Unit:*

- Ana Armada (Assistant Researcher): **28 hours** (2h L; 8h TP; 14h LP; 2,5h S; 1,5h T);
- Paulo Almeida (Full Professor): **8 hours** (2h L; 2h LP; 2,5h S; 1,5h T);
- Teresa Novo (Assistant Professor): **6 hours** (2h LP; 2,5h S; 1,5h T);
- Jorge Seixas (Associate Professor): **6 hours** (2h L; 2,5h S; 1,5h T);
- Guest lecturer(s): **2 hours** (2 TP).

### *Legend:*

L – Lecture; TP – Theory-Practice; LP – Laboratory Practice; S – Seminar; T – Tutorial; E – Exam

### *Intended learning outcomes (knowledge, skills and competences to be developed by the students):*

By the end of this course students should be able to:

- Understand the re-emerging nature of leptospirosis and Lyme borreliosis as zoonotic diseases with a high impact on global health (situation in Portugal and worldwide);
- know the natural reservoirs (rodents) *versus* competence for the transmission of pathogenic species of *Leptospira*, and the main species of vectors (ticks) involved in the transmission of *Borrelia* species of *B. burgdorferi* sensu lato (s.l.) complex and other borreliae;
- Understand the interaction of host cells during infection with *Leptospira* spp (Leptospirosis) and *Borrelia burgdorferi* s.l. (Lyme borreliosis).
- Know the main clinical manifestations of leptospirosis and Lyme borreliosis, and the respective therapeutic and/or prophylactic approaches;
- Know and perform the main laboratory diagnostic techniques [screening and reference (confirmation) at the serological, immunological and molecular level] and its advantages and limitations;
- Analyze and critically evaluate laboratory results, integrating them into the epidemiological and clinical context;
- Know the main prevention, control and epidemiological surveillance plans for the two spirochetosis;
- Know the current trends in research into the two zoonotic spirochetes / spirochetosis.

#### **Syllabus:**

##### **Lectures (L)**

- Leptospire and leptospirosis: an update on the subject;
- Ixodids (ticks) as vectors of *Borrelia* spp;
- The importance of rodents in the epidemiology of leptospirosis and in the zoonotic cycle of Lyme borreliosis agents;
- Borreliae and Lyme borreliosis: an update on the subject;
- The interaction of host cells in infection by *Leptospira* spp and *Borrelia burgdorferi* s.l., effects on the respective diseases;
- Leptospirosis and Lyme borreliosis - clinical perspective.

##### **Theoretical-Practical Classes (TP)**

- Leptospirosis and laboratory support;
- Spirochetes and research - experience of former master's students in medical microbiology; Current challenges and projects (with guest speakers);
- Lyme borreliosis and the laboratory - introduction to different approaches;
- Round Table - Discussion of the results obtained in the practical classes.

##### **Laboratory Practice (LP)**

- Observation of leptospire (*in vitro* cultures on EMJH selective medium) under darkfield microscopy;



- Laboratory diagnosis [MACROLepto and MAT (screening test and WHO reference test)] respectively;
- Laboratory diagnosis (continued). Molecular tests for diagnosis of human leptospirosis (conventional PCR and nested-PCR);
- Molecular detection of *Leptospira* spp in environmental samples (real-time PCR)
- Morphological observation/identification of ixodids [ticks (=vectors)] - main genera and species involved in the transmission of spirochetes of the *Borrelia burgdorferi* s.l. complex, using dichotomous keys;
- Observation of borreliae (*in vitro* cultures kept in BSK selective medium) under darkfield microscopy;
- Lyme borreliosis / Laboratory diagnosis (IFA and Western blot tests);
- *Borrelia burgdorferi* s.l., complex and other borreliae - Molecular tests: nested-PCR and real-time PCR (diagnosis and research); genomic identification (e.g. PCR-RFLP, RLB, ...).

#### **Seminar (S)**

- Oral presentations (by students) and respective discussion of previously distributed articles on the subject of the course.

#### ***Evidence of the syllabus coherence with the CU intended learning outcomes:***

The lectures provide a framework for the main theoretical foundations so that students can achieve the objectives proposed in the other learning units (classes), both theoretical-practical and laboratory. It is important to highlight the importance of the students' participation in a round table, which is part of the Curricular Unit Programme, with the aim of consolidating the skills acquired. In this activity, students critically discuss the results obtained in the various laboratory approaches carried out, and have the opportunity to communicate them to their classmates and lecturers through short oral presentations, identifying critical points in the procedures carried out and establishing correction criteria, where necessary.

#### ***Teaching methodologies (including assessment):***

Lectures and interactive classes supported by slides and/or videos and the availability of bibliography (12 contact hours); Theoretical-practical classes supported by slides and/or videos (8 contact hours), including a Round Table to discuss the results obtained in the practical laboratory component; Practical laboratory classes are orientated towards the execution of various laboratory diagnostic protocols (experimental situations and/or clinical cases), as well as some case study research approaches (16 contact hours); a Seminar with oral presentations by the students with all the teachers involved in teaching the course syllabus (2.5 contact hours).

At the end of the Curricular Unit, the teachers provide tutorial support to clarify any doubts (1.5 contact hours). In terms of assessment, both the Round Table and the Seminar are evaluations moments with previously defined weights. The final assessment is the result of these evaluations



and a written exam (2 hours) consisting of 36 multiple-choice questions (with 5 options) and four (4) development questions, from which students choose two (2).

Students with at least 2/3 attendance are admitted to the Curricular Unit assessment. For the evaluation, various components are considered with their own weightings [attendance and participation in the Round Table (20%), and Seminar (30%)]. The final assessment is therefore the result of these evaluation components and a written exam (50%) consisting of multiple-choice questions (n=36) and four development questions from which students choose two (2). Approval is obtained with a mark of 10 or more (0-20 scale).

***Evidence of the teaching methodologies coherence with the Curricular Unit intended learning outcomes:***

In laboratory practical classes (PL), students apply the content taught in the theoretical (L) and theoretical-practical (TP) classes of the subject, allowing them to relate the biology and pathogenesis of the two zoonotic spirochetes (*Leptospira* and *Borrelia*) and their impact on the health of populations (human and animal), without neglecting the current environmental context of these bacteria in accordance with the current concept of 'One Health'.

The lessons on ixodids (ticks) as vectors of borreliæ and the importance of rodents in the epidemiology of leptospirosis consisted, respectively, of lectures and interactive lessons with the students, enabling them to learn about and describe the role of ticks in Lyme borreliosis and the vector-parasite relationships in transmission, and the role of rodents as reservoirs of leptospires. The lesson on the morphological identification of ticks is a practical laboratory lesson (LP) in which students develop technical skills, particularly in the use of dichotomous keys to identify these arthropods. The lesson on the interaction of host cells in the face of infection by spirochetes and the lesson on clinical aspects will allow students to relate epidemiology, the host's immunological response, the laboratory and the clinic in an integrated approach to the different tropisms and pathogenicity of the bacterial agents under study.

The acquisition of skills for interpreting and critically arguing the results obtained in the laboratory classes is stimulated by the active participation of students in a round table, in which the teachers involved in these learning units also take part. Oral presentations (Seminar) and a written test will show the knowledge acquired and its understanding, as well as the application of knowledge in new situations.

***References for consultation / mandatory existence:***

Students have access to the lecture slides (PPT) and video links via the available institutional platform (Moodle), to the Laboratory Manual prepared and updated for the current edition of the Master's Programme, including the protocols and theoretical basis of each technique, as

well as to the basic bibliography listed below, which will be supplemented with other updated bibliographic elements during the course.

- Adkison H and Embers ME. (2023). Lyme disease and the pursuit of a clinical cure. *Front Med*, 10:1183344. [doi: 10.3389/fmed.2023.1183344](https://doi.org/10.3389/fmed.2023.1183344)
- Bradley EA, Lockaby G. (2023). Leptospirosis and the Environment: A Review and Future Directions. *Pathogens*, 12(9):1167. <https://doi.org/10.3390/pathogens12091167>
- Castro R, Nuncio S, Vieira ML. (2014). *Treponema, Borrelia e Leptospira*. in Parte 4 - Bacteriologia Médica. Cap. 35: 444-466. Microbiologia Médica, vol. 1. Meliço-Silvestre A, Barroso H & Nuno Taveira editores, Lidel, Edições Técnicas, Lisboa, Portugal.
- Cerar T, Strle F, Stupica D, Ruzic-Sabljic E, McHugh G, Steere AC, Strle K. (2016). Differences in Genotype, Clinical Features, and Inflammatory Potential of *Borrelia burgdorferi* sensu stricto strains from Europe and the United States. *Emerg Infect Dis*, 22(5): 818-827. <https://dx.doi.org/10.3201/eid2205.151806>
- Costa F, Hagan JE, Calcagno J, Kane M, Torgerson P, Martinez-Silveira, MS, et al. (2015). Global Morbidity and Mortality of Leptospirosis: A Systematic Review. *PLoS Negl Trop Dis*, 9(9), e0003898. <https://doi.org/10.1371/journal.pntd.0003898>
- Martins M, Castro R, Vieira ML. (2014). Métodos de Diagnóstico Serológico. in Parte 3 - Princípios do Diagnóstico Microbiológico Médico. Cap 16: 170-181. Microbiologia Médica vol. 1. Meliço-Silvestre A, Barroso H & Nuno Taveira editores, Lidel, Edições Técnicas, Lisboa, Portugal.
- Peacock BN, Gherezghiher TB, Hilario JD, Kellermann GH. (2015). New insights into Lyme disease. *Redox Biol*, 5, 66-70. [doi: 10.1016/j.redox.2015.03.002](https://doi.org/10.1016/j.redox.2015.03.002)
- Petakh P, Behzadi P, Oksenykh V and Kamyshnyi O. (2024). Current treatment options for leptospirosis: a mini-review. *Front. Microbiol*, 15:1403765. [doi: 10.3389/fmicb.2024.1403765](https://doi.org/10.3389/fmicb.2024.1403765)
- Picardeau M. (2013). Diagnosis and epidemiology of leptospiroses. *Méd et Maladies Infect*, 43, 1–9. <http://dx.doi.org/10.1016/j.medmal.2012.11.005>
- Picardeau M (2015). Leptospirosis: Updating the Global Picture of an Emerging Neglected Disease. *PLOS Negl Trop Dis*, 9(9): e0004039. <https://doi.org/10.1371/journal.pntd.0004039>
- Varma MRG. (1993). Ticks and mites (Acari). *Medical Insects and Arachnids*. Lane, RP & Crosskey RW, eds., pp. 597-658. Chapman & Hall, London, UK.
- Wang G, Liveris D, Mu Kherjee P, Jungnick S, Margos G, Schwartz, I. (2014). Molecular typing of *Borrelia burgdorferi*. *Current Protocols Microbiol*, 34, 12C.5.1-12C.5.31.
- Lucca V, Nuñez S, Pucheta MB, Radman N, Rigonato T, Sánchez G, Del Curto B, Oliva D, Mariño B, López G, et al. (2024). Lyme Disease: A Review with Emphasis on Latin America. *Microorganisms*, 12(2):385. <https://doi.org/10.3390/microorganisms12020385>