

1. Course description

The development of diverse and recent approaches (genome-wide studies, single cell analysis, biophysics, modelling, chemobiology, etc.) has revealed key aspects of microbial biology and ecology, which will be explored in this course.

For the 2026-2027 edition, the broad theme of “**interactions**” had been selected as a common thread for the week. Conferences will cover the mechanisms of perception of and adaptation to the environment, mono- and multi-species interactions between microorganisms, individual and collective behaviors, as well as interactions between hosts, pathogens and the microbiota.

Keywords: Microorganisms | Bacteria | Microbial communities | Microbiota | Evolution | Microbial ecosystems | Cross-kingdom interactions | Infection | Host-pathogen interactions | Virulence | Metagenomics | Immunity | One health | Interdependence | Antimicrobials

Topics covered

✓ *Bacterial physiology in the environment*

Mechanisms controlling bacterial cell structure and cycle, bacterial adaptation, motion, stress responses and differentiation in response to environmental cues are central to Microbiology. Lectures will highlight what can be brought by single cell imaging, molecular biology and modelling approaches to the study of molecular machines and regulatory networks.

✓ *Evolution and ecology of microorganisms*

Bacteria adapt and co-evolve as part of ecosystems, thereby contributing to shaping their niche, either locally or at a global scale. The diversity and functional complexity of microbial communities known as microbiota will be highlighted, as well as their structure, dynamics, and consequences on host physiology or environmental ecosystems. Relationship between the animal or plant microbiota and health will be drawn, and extended to the notion of “*One health*”. Lectures will also emphasize how the thorough and functional analysis of microbial —omics (genomics, but also metagenomics, transcriptomics, proteomics, etc.) contribute to a better understanding of bacterial diversity and inter-species interactions.

✓ *Host-pathogen interactions and infectious diseases*

Pathogenic bacteria interact with their host during infection, thus leading to a perturbation of cell or tissue functions and causing disease. Processes involved in bacterial adherence, injection of effectors, invasion of host cells, intracellular trafficking and spread of bacteria will be covered. Mechanisms of pathogen adaptation to their hosts and avoidance of host defenses will be discussed. The most recent approaches allowing high-resolution imaging and dynamic understanding of the progression from infectious agents to disease will be highlighted.



2. Organization

Location: Biology Department, 3rd floor - Room **305**, at ENS, 46 rue d’Ulm, 75005 Paris.

To enter the building, an access card is required; visitors must use the intercom at the entrance. The building, floor and classroom are accessible to people with disabilities.

Duration: 5 days from November 2 to 6, 2026 | 27 hours in person.

Hours: 9 a.m.-5 p.m. with breaks. The Thursday afternoon is left free. For details, refer to the section [Detailed schedule and content](#) below.

Homework: Preparation of a chalk talk in small groups; revisions prior to the exam.

Maximum class size: 24 students. The class is taught in English.

3. Coordination

Olivier Espéli, DR CNRS, CIRB group [Functioning and Adaptation of Microorganisms](#), Collège de France;

Alice Lebreton, Professor in the Biology Department, IBENS group [BIRD](#), ENS-PSL.

Preferred method of contact: e-mail (see contact information [here](#)).

4. Registration

IMaLiS students will be registered for the course by our administration.

Students external to the ENS Biology Department can attend classes after contacting the course coordinator to receive approval (see contact information [here](#)). Subsequently, students will need to register online at least one week before the course starting date by following the instructions on our website:

<https://www.enseignement.biologie.ens.fr/?article207>.

5. Course communication

The course organizers will most often contact students by e-mail for announcements and for specific information or inquiries regarding the course and exam schedules, as well as for urgent updates.

The course material — PDF versions of presentations — will be made available via the [Moodle](#) platform of the biology department.

6. Course prerequisites

Students are expected to master bachelor-level knowledge in molecular and cellular biology (gene regulation, organization of prokaryotic and eukaryotic cells, signaling, etc.), principles of evolution and classical concepts in bacterial genetics to follow the lectures. Bachelor level in genetics, evolution, biochemistry, biophysics, or medical studies usually provide appropriate prerequisites. Students should have already acquired skills in interpreting research results.

The content of the UEs [UNBIO1-001 \(Methodological workshop\)](#), [UNBIO1-011 \(Molecular Biology & Genetics\)](#), [UNBIO1-047 \(Microbial populations\)](#), or an equivalent is relevant to this course.

7. Course format, teaching methods and special activities

After introductory lectures by the two course organizers, the course will include a series of 11 conferences of 1.5 to 2 hours developing the concepts of microbial interactions with biotic and abiotic cues in their environment. Guest speaker will illustrate these concepts with a selection of examples from their research, introducing leading-edge approaches to their biological questions.

Special activities: Preparation of chalk-talks on topics related with microbes in small groups.

8. Expected learning outcomes

Upon completion of the course students will be able to:

- ✓ read, analyze, and present current research articles in microbiology;
- ✓ explain how bacteria are able to sense biotic and abiotic cues in their environment and launch adaptive responses;
- ✓ outline the processes ruling the overall organization of microbial communities, including biofilm formation, quorum sensing, exchange of genetic information or mechanisms of bacterial antagonism;
- ✓ discuss how collective behaviors emerge among microbial populations;
- ✓ describe the dialogue between hosts, their microbiota and microbial pathogens;
- ✓ apply knowledge about molecular cell biology and bacterial genetics to the study of microbe-host interactions and infectious diseases;
- ✓ connect knowledge about metal chemistry, metabolism and antibacterial defenses;
- ✓ follow courses of advanced microbiology or virology, e.g. [Microbial Ecosystems & Climate Change](#) or [Advanced Biology Course on Virology and Infection](#);
- ✓ identify state-of-the art approaches to probe microbial functions, at the single cell or population levels;
- ✓ undertake a Master's degree research internship or a PhD thesis on a research topic related to microbiology or to host-pathogen interactions.

9. Detailed schedule and content

Monday November 2nd — Welcome at the frontiers

- 09:00 – 10:30 **Olivier Espéli**, CIRB (Collège de France) — Introduction to bacterial cell physiology.
- 10:45 – 12:15 **Alice Lebreton**, IBENS (ENS-PSL) — Introduction to host-pathogen interactions.
- 14:00 – 16:00 **Maxence Vincent**, LCB (CNRS-Aix-Marseille Université) — Reactive chemistry at the host-microbe interface.
- 16:15 – 17:00 *Group chalk presentations: selection of topics related to the course.*

Tuesday November 3rd

- 09:00 – 10:30 **Sylvie Lautru**, I2BC (CNRS, Université Paris-Saclay) — TBA.
- 10:45 – 12:15 **Raphaël Jeanneret**, LPENS (ENS-PSL) — Shedding light on phototaxis: collective phenomena in micro-algae.
- 14:00 – 16:00 **Dorothée Murat**, LCB (CNRS-Aix-Marseille Université) — Motility and polarity control in environmental bacteria.

Wednesday November 4th

- 9:00 – 10:30 **Maude Guillier**, IBPC (Paris) — TBA.
- 10:45 – 12:15 **Thais Vilela Rodriguez**, Institut Pasteur — TBA.
- 14:00 – 16:00 **Isabelle Virlogeux-Payant**, ISP (INRAE, Nouzilly) — How the past decade has revolutionized our understanding of *Salmonella* interactions with host cells.

Thursday November 5th

- 09:00 – 10:00 *Preparation of flash group chalk presentations on the selected topics.*
- 10:15 – 12:15 **Kimberley Kline**, University of Geneva — TBA.

Friday November 6th

- 09:00 – 10:30 **Sandrine Bourdoulous**, Institut Cochin (Paris) — TBA.
- 10:45 – 12:15 **Christian Lesterlin**, IBCP (CNRS, Lyon) — TBA.
- 14:00 – 15:30 **Éric Cascales**, LISM (CNRS-Aix-Marseille Université) — TBA.
- 15:45 – 17:00 *Flash group chalk presentations on the selected topics.*

The exam is taking place in December (date to be confirmed)

10. Evaluation and grading

The course is credited with 3 ECTS. The exam consists in a written exam, usually for 2 h at the end of the 1st semester. It will either consist in an essay elaborating on the course contents and examples taken from conferences, or in questions related to research articles in line with the topics covered during the week, or specific analytical questions on research data. The students' active participation during the week and for the chalk talk is also taken into account as a bonus on the final grade (usual range: 0 to 2 extra points).

In case of a failure to validate the course (grade <10), a resit may be taken. It will be organized during the week of February 8-12. The resit grade is capped to 12 (all points above 10 are divided by 5) unless a medical certificate is provided to justify an absence at the first session of the exam.

11. Absence, class participation and classroom etiquette

Students are expected to arrive in time, to attend all classes in person, to actively participate and to focus on the class during the course. Students should notify the course coordinator in advance in case of an exceptional absence. Absences for health reasons require a medical certificate.

To foster a positive learning environment, students and lecturers have a shared responsibility. We seek to create a welcoming and respectful environment, which implies a complete immersion in the activities of the class, without interference from extraneous activities.

Disclaimer: Information contained in this syllabus may be subject to change with reasonable advance notice, as deemed appropriate by the coordinators of the course.