

Partager

Email destinataire :

Vous devez renseigner un email valide

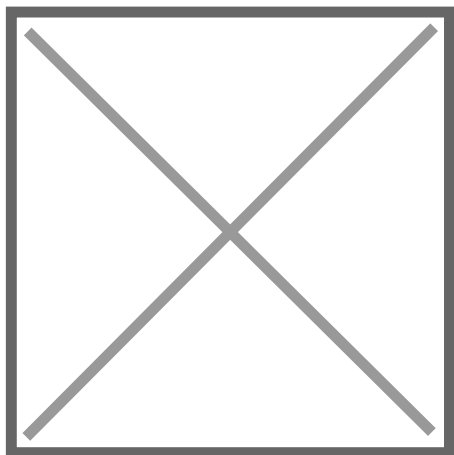
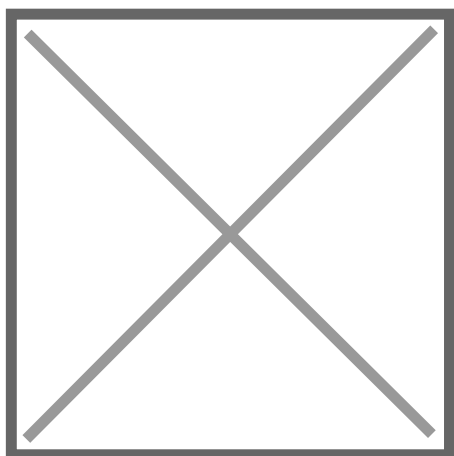
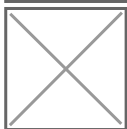
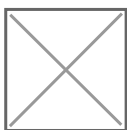
Envoyer

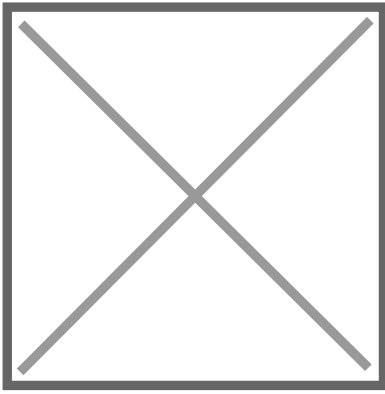
Une erreur est survenue. Merci de réessayer ultérieurement

Le mail de partage a bien été envoyé.

Ajouter au comparateur

M2 Microbiologie fondamentale





Master
Mention Microbiologie
Régime(s) d'inscription
Formation initiale Formation continue
Langue(s) d'enseignement
Anglais

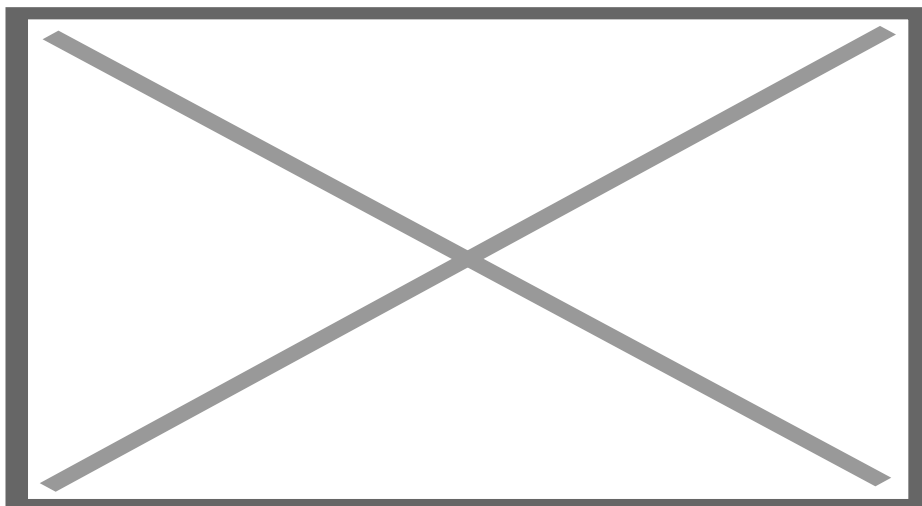
"Shaping the future of Microbiology: explore, understand, innovate"

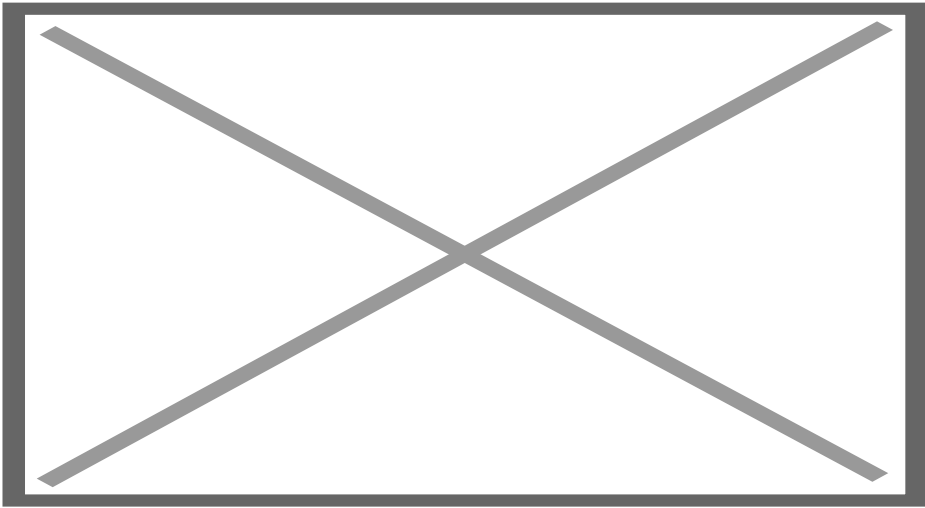
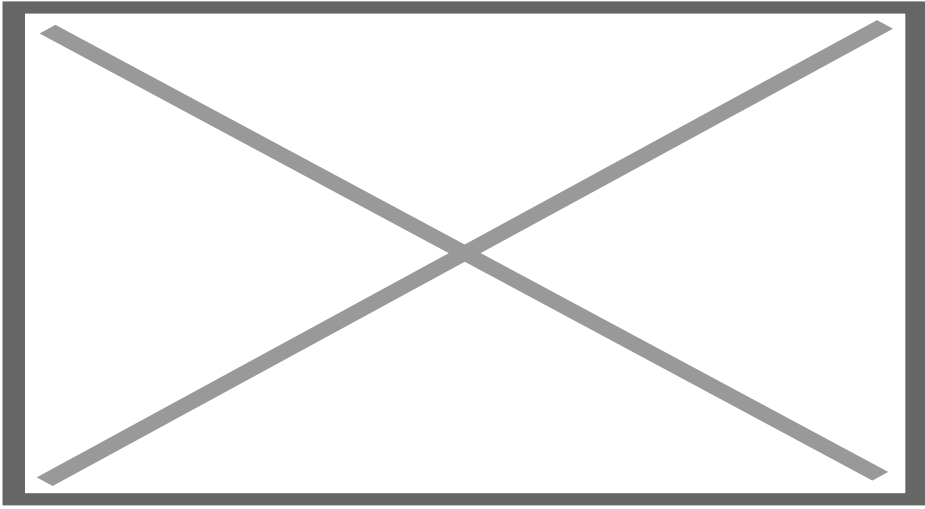
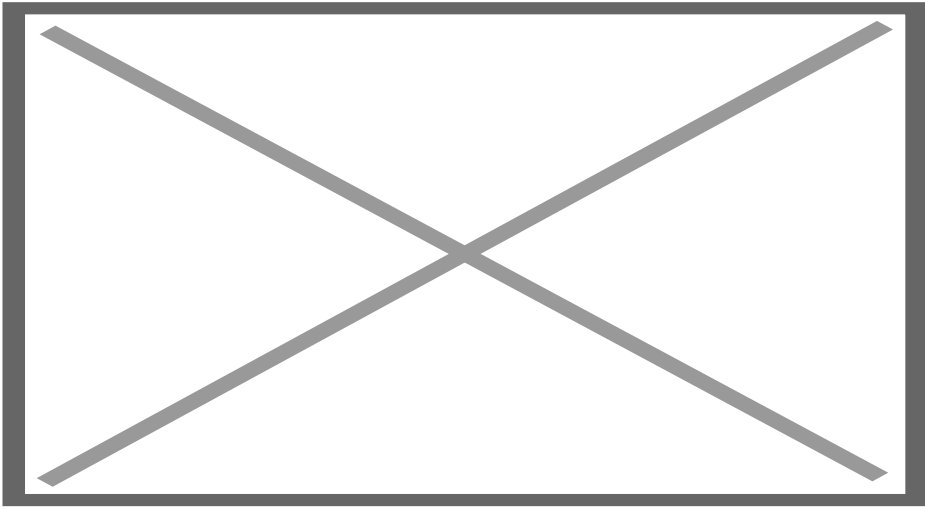
Le programme est conçu pour inspirer et former la prochaine génération des microbiologistes en proposant une formation multidisciplinaire axée sur la recherche et fondée sur les dernières découvertes en génétique, génomique, biologie cellulaire et physiologie microbienne. Un large éventail de modèles et de sujets permet d'explorer la diversité microbienne au niveau moléculaire, cellulaire ou intégré (communautés, hôtes).

Le parcours est organisé en deux cursus « Molecular and Cellular Microbiology » et « Virology », composés d'enseignements communs en génomique fonctionnelle, microbiologie synthétique et à l'exploration de données à l'aide d'outils bioinformatiques, et d'enseignements spécifiques de chaque cursus ainsi qu'un large panel d'unités d'enseignement au choix permettant d'acquérir des compétences en biologie de la cellule microbienne, interactions microbiennes, virologie des eucaryotes et des procaryotes, entre autre.

Un cours pratique de Microbiologie intégrative de deux semaines est proposé. Ce cours labélisé « Paris-Saclay » est organisé autour de thématiques-phares de la communauté des microbiologistes de Paris-Saclay au sein des laboratoires I2BC ou MICALIS, principalement. Elle vise à mettre l'étudiant en situation "Recherche". Cet ancrage fort dans l'environnement Recherche s'illustre par l'implication des équipes de Recherche dans l'enseignement au sein même des Instituts.

[Télécharger la fiche détaillée](#)
[Je candidate](#)







■ ■

Informations

- [Présentation](#)
- [Admission](#)
- [Programme](#)

Présentation

Compétences

- Maîtriser les connaissances fondamentales concernant la diversité du monde microbien et les domaines de la génétique, génomique avec un focus plus particulier sur la biologie de la cellule microbienne pour le cursus « Molecular and Cellular Microbiology » et davantage tourné vers la compréhension des cycles viraux des cellules eucaryotes et procaryotes pour le cursus « Virology », les deux cursus incluant une vision intégrée des mécanismes moléculaires aux interactions cellulaires.
- Développer un savoir-faire expérimental et une maîtrise des approches ciblées et globales dans le domaine de la Microbiologie (design expérimental, clonage, culture microbienne ou analyse des cycles viraux, extraction et analyses quantitatives d'acides nucléiques ou de protéines, analyse et représentation de jeux de données, notamment).
- Développer un savoir-faire dans le domaine de l'exploration et de la représentation de données (niveau : initiation à l'utilisation de R).
- Communiquer en anglais dans le contexte scientifique (comprendre des séminaires, recevoir des instructions, présenter le contexte scientifique et des résultats expérimentaux, poser des questions et répondre à des questions en anglais).
- Mener en toute autonomie un projet scientifique, et pouvoir communiquer une analyse critique des résultats, à l'oral et l'écrit, en respectant les standards internationaux dans le domaine de la Microbiologie.
- Développer la capacité à travailler en équipe autour de projets bibliographiques et expérimentaux ayant trait à la Microbiologie.

Objectifs pédagogiques de la formation

Le programme est international et met l'accent sur la recherche afin de préparer les étudiants aux défis modernes de la microbiologie. Il couvre une variété de modèles (bactéries, archées, micro-organismes eucaryotes, virus) et plusieurs échelles d'analyse, des molécules aux génomes, cellules et communautés.

Au cours du premier semestre, les étudiants acquièrent des connaissances en génomique et en ingénierie du vivant grâce au programme de base « Explorer et innover », complété par des cours pratiques et des unités d'enseignement optionnelles dans les domaines de la microbiologie moléculaire et cellulaire, de la virologie eucaryote et procaryote, des interactions microbiennes et de la pensée critique utilisant l'intelligence artificielle, entre autres.

Pendant le second semestre l'étudiant(e) réalise un stage de M2 en laboratoire qui correspond à une formation qualifiante à travers une activité de recherche de 6 mois dans un domaine ayant trait à la Microbiologie. Il permet de former l'étudiant(e) aux techniques expérimentales mais aussi à la rédaction de projet(s) et à la communication scientifique orale. Le stage peut se dérouler au sein des laboratoires de Paris-Saclay [Institut de Biologie Integrative de la Cellule (I2BC), MICrobiologie de l'ALimentation au Service de la Santé Humaine (MICALIS), L'Institut Diversité, Écologie et Évolution du Vivant (IDEEV), Laboratoire de Biologie et de Pharmacologie Appliqué (LBPA, ENS Paris-Saclay)], des grands instituts de recherche de Paris centre (Institut Pasteur, Institut Jacques Monod), en région ou à l'étranger.

Le taux de réussite des étudiants inscrits au M2 Fundamental Microbiology est de 94 % (2015-2025). Le taux de poursuite en thèse des étudiants diplômés s'élève en moyenne à 61 % (2015-2025). Ces thèses sont réalisées à 55 % dans un laboratoire de l'Université Paris-Saclay (UPSaclay), 33 % dans un laboratoire français non UPSaclay et 12 % à l'étranger. Environ 13 % des diplômés s'insèrent dans le monde socio-économique à Bac+5 (emploi d'ingénieur d'études ou d'enseignants agrégés ou de chargé de communication au sein d'un institut de Recherche) et environ 20 % poursuivent leurs études (cursus ENS, filière médicale, attaché.e de recherche clinique, etc.).

Débouchés

Professionnels

Après un Master ou Master + Doctorat : ingénieur (R&D, contrôle, production...)

Après un Master ou Master + Doctorat : ingénieur (recherche-développement, contrôle, production...) dans les domaines santé, pharmacie, agroalimentaire, biotechnologies, instruments et réactifs, cosmétique, dépollution et environnement

Secteurs d'activité : recherche fondamentale ou appliquée en Biologie, Santé ou Écologie dans le monde académique ou dans le secteur privé

Domaines : santé, pharmacie, agroalimentaire, biotechnologies, instruments et réactifs, cosmétique, dépollution et environnement
Après Master + Doctorat : chercheur ou enseignant-chercheur
Après un Master ou Master + Doctorat : ingénieur (recherche et développement, contrôle, production...)
Ingénieur d'études / de recherche dans un service R&D dans l'industrie ophtalmique
Ingenieur R&D
Responsable de projets R&D
Responsable de projets R et D
Chef de projet
Ingénieur d'études dans les domaines de l'industrie
Ingénieur d'études dans les domaines de la recherche
Ingénieur d'études industrie / recherche publique
Sous réserve de réussite au concours de la fonction publique, les diplômés pourront accéder à des postes d'ingénieur d'étude ou chercheur au sein d'un organisme national de recherche
Enseignants-chercheurs
Ingénieur.e d'études
Ingénieur.e recherche & développement
Chargé.e de recherche et innovation
Chargé.e de projet
• Chargé.e de communication scientifique, veille technologique ou transfert de technologie
Chef.fe de projet en biotechnologies, biothérapies ou innovation en santé
Chargé.e de communication scientifique, veille technologique ou transfert de technologie
Ingénieur.e recherche et développement
Ingénieur de recherche ou d'études
métiers de la recherche
enseignant.e-chercheur.se (après un doctorat)
ingénieur.e d'étude
ingénieur.e de recherche

enseignant.e (après le concours du CAPES ou de l'agrégation)

Chargé de mission / projets

Ingénieur d'études

Ingénieur de recherche

consultant

Recherche en santé-environnement (analyse, toxicologie, microbiologie)

Poursuite d'études

Biologie-AgroSciences

Cette orientation prépare en particulier aux activités de recherche appliquée, généralement exercées après un doctorat, que ce soit dans le milieu académique ou en R&D.

Chercheur/chercheuse en R&D ou expert.e en modélisation et analyse de données dans des entreprises ou laboratoires de pointe.

Doctorat

Doctorat en Bioinformatique

Doctorat en Chimie / Biologie

Les étudiants de cette mention peuvent se tourner vers la recherche à l'issue du M2

Les étudiants titulaires d'un M2 ont la possibilité de poursuivre dans la recherche en doctorat

Ingénierie études, recherche et développement

S'ouvrir aux secteurs connexes et d'appréhender l'environnement des professions de santé, de maîtriser la réglementation applicable aux produits de santé, et de conseiller les promoteurs de projets scientifiques pour aider à la valorisation de celle-ci

Thèse de doctorat

Agenda

Début de la formation (date indicative)

07/09/2026

Admission

Capacité d'accueil

Places

16

Public visé et prérequis

Profil des étudiants : principalement scientifiques (universités ou ENS), quelques ingénieurs, et plus rarement étudiants des filières médecine ou pharmacie.

Environ 50 % de la promotion est constituée d'étudiants internationaux.

Ce parcours s'adresse aux étudiants ayant validé niveau M1 des compétences en génétique et biologie moléculaire, et des connaissances théoriques et/ou expérimentales dans le domaine de la Microbiologie sensu lato (bactéries, archées, microorganismes eucaryotes, virus).

A titre d'exemple, nous recommandons aux étudiants du M1 Microbiologie de suivre, en plus du socle (qui permet de valider des compétences en génétique, génomique, biologie cellulaire, notamment), les unités d'enseignement (UE) « Génétique et physiologie microbienne », « Integrative Microbiology », « Évolution et diversité des microorganismes » et/ou « Génomique fonctionnelle ». Pour les étudiants souhaitant suivre le cursus « Virology », une UE de Virologie est fortement recommandée telles que « Virologie fondamentale » ou « Integrative Virology ».

Période(s) de candidature

Plateforme Inception

Du 27/01/2026 au 20/07/2026

Pièces justificatives

Obligatoires

Lettre de motivation.

Tous les relevés de notes des années/semestres validés depuis le BAC à la date de la candidature.

Curriculum Vitae.

Facultatives

Descriptif détaillé et volume horaire des enseignements suivis depuis le début du cursus universitaire.

Dossier VAPP (obligatoire pour toutes les personnes demandant une validation des acquis pour accéder à la formation) <https://www.universite-paris-saclay.fr/formation/formation-continue/validation-des-acquis-de-lexpérience>.

D'éventuelles lettres de recommandation.

Fiche de choix de M2 (obligatoire pour les candidats inscrits en M1 à l'Université Paris-Saclay) à télécharger sur <https://urlz.fr/i3Lo>.

Document justificatif des candidats exilés ayant un statut de réfugié, protection subsidiaire ou protection temporaire en France ou à l'étranger (facultatif mais recommandé, un seul document à fournir) :

- Carte de séjour mention réfugié du pays du premier asile
- OU récépissé mention réfugié du pays du premier asile
- OU document du Haut Commissariat des Nations unies pour les réfugiés reconnaissant le statut de réfugié
- OU récépissé mention réfugié délivré en France
- OU carte de séjour avec mention réfugié délivré en France
- OU document faisant état du statut de bénéficiaire de la protection subsidiaire en France ou à l'étranger.

Programme

Virology track

Core curriculum: Knowledge in genomics and life engineering "Explore and Innovate"

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Initiation to data exploration with R	3	Semestre 1	10	10							

Initiation to data exploration with R

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Objectifs d'apprentissage

This course introduces students to R software for analyzing biological datasets generated by high-throughput omic technologies. Through a blend of theory and hands-on practice, students will learn to use R for data exploration, analysis, and visualization in biological research.

Organisation générale et modalités pédagogiques

The course is structured around interactive teaching days, featuring practical training for direct application of concepts, live and pair programming sessions to encourage collaboration and problem-solving, and a project tailored to each student's initial skill level, ensuring personalized growth and mastery. To reinforce learning, self-assessment tests are provided. Evaluation: Continuous assessment, including project evaluation.

Nature de l'évaluation

Evaluation Continue non Intégrale

[Cellular
innovations and
new concepts in
synthetic
microbiology](#)

3

Semestre 1 20

Cellular innovations and new concepts in synthetic microbiology

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

M1 level in Molecular biology

Objectifs d'apprentissage

This course aims to establish the key concepts underlying recent advances in the field of synthetic microbiology.

Organisation générale et modalités pédagogiques

Through examples of fundamental and applied issues, the conferences will illustrate how and why synthetic biology approaches can contribute to understanding how living organisms work, generate microbial strains that are improved in terms of efficacy and/or safety and open up new fields of research in biology. Conferences on history and ethics surrounding these fields of investigation will address the question of the positioning of synthetic biology in society and in the evolution of research. Students will be evaluated on the synthetic biology project they have developed (10-15 min oral + written report). The project will be evaluated on its originality, coherence/relevance, feasibility and mastery of the scientific context around the issue raised by the student.

Session 1 & Session 2 : F = 0.5 x report + 0.5 x oral presentation (the report corresponds to the synthetic biology project; report and oral presentation in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

[Functional Genomics](#)

3

Semestre 1 20

5

Functional Genomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

M1 level in genomics, genetics and molecular biology

Organisation générale et modalités pédagogiques

This teaching unit explores the latest advances and innovative concepts in functional genomics. Led by leading experts in the field, the course will cover cutting-edge scientific developments in comparative genomics, metagenomics, transcriptomics, proteomics, and their applications.

Key objectives:

- Bridge the gap between scientific questions and the most effective methodologies to address them.
- Foster critical discussions on how global approaches in genomics are reshaping our understanding of gene function and the genome 'dark matter'.

Interactive learning:

- Roundtable discussions between students and researchers to explore the impact of emerging concepts in genomics.
- A one-day mini-symposium where students present their own reviews on self-selected themes, encouraging active participation and deeper engagement with the material

Nature de l'évaluation

Evaluation Continue non Intégrale

[Advanced Cellular
and Molecular
Virology of
Eukaryotes](#)

6

Semestre 1 20

20

Advanced Cellular and Molecular Virology of Eukaryotes

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 20

Projet tutoré 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

This teaching unit is designed for students with a **strong foundation in molecular and cellular biology**.

Participants are expected to be familiar with fundamental concepts in cell structure and function, nucleic acid biology, protein synthesis, and basic immunology. Prior exposure to **general microbiology and/or virology is recommended** to facilitate understanding of viral replication strategies and host–virus interactions. Students are expected to be **comfortable reading and interpreting primary scientific literature** and have familiarity with experimental techniques commonly used in molecular and cellular biology (cell culture/transfection, electrophoresis, immunoblotting, PCR/qPCR, immunostaining, microscopy, flow cytometry).

Programme / plan / contenus

This teaching unit aims to provide Master 2 students with a **strong and detailed knowledge of the molecular and cellular mechanisms that govern the replication cycles of viruses** infecting eukaryotic cells. Emphasis will be placed on the **structure and function of viral components, virus–host interactions**, and the application of **cutting-edge technologies** that have shaped current knowledge in the field.

Through a series of **lectures delivered by expert researchers** and complemented by **interactive discussions and student presentations**, participants will explore fundamental and emerging concepts in molecular virology.

Topics will include, but are not limited to:

- Structure and function of viral fusion glycoproteins
- Mechanisms of virus entry into target cells

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications	3	Semestre 1	20								

Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Completion of introductory courses in Molecular Biology and Microbiology

Objectifs d'apprentissage

The past decade has seen an **explosion** in the discovery of prokaryotic antiviral defenses—far beyond restriction-modification and CRISPR—revealing a hidden world of molecular innovation. This course explores the evolutionary arms race between prokaryotes and their viruses, uncovering how these ancient systems not only shape microbial ecosystems but also share striking parallels with eukaryotic innate immunity. From cyclic nucleotide signaling to phage abortive infection, these mechanisms offer a window into the origins of immunity itself and challenge our understanding of genetic conflict. Join us to dive into the cutting edge of microbial immunity, where ancient battles fuel modern breakthroughs.

Organisation générale et modalités pédagogiques

In groups of 2–3, students analyze a course-related article and present it on Friday, followed by Q&A with an opposing group. Grades are based on **presentation quality, article analysis, responses to questions, and participation.**

Nature de l'évaluation

Evaluation Continue non Intégrale

Elective teaching units in the field of microbial interactions for Virology track

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
<u>Introduction to Metagenomics</u>	3	Semestre 1	10	10							

Introduction to Metagenomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Basic knowledge in microbiology with high interest in the biology of bacteria, phages, and plasmids interacting in communities and in interactions with pluricellular hosts. Strong interest in genomics, big data analysis, and bioinformatics. A mobile, personal computer is required for this course (as it cannot be provided).

Objectifs d'apprentissage

This course provides a basic and comprehensive introduction to the dynamic field of metagenomics, which is essential for understanding microbiome-host (holobiont) interactions. Participants will explore diverse topics such as the human gut microbiome, plant-microbe interactions, and the roles of viruses (the 'virome') within microbiomes. Metagenomics is key in advancing our understanding of microbial diversity, ecosystem dynamics, and their implications for health, agriculture, and the environment.

Organisation générale et modalités pédagogiques

Lectures will be given by experts in the field, and participants will analyze real-world datasets by gaining hands-on experience with R (RStudio), computing clusters, and command-line tools. The approaches will include data pre-processing, community analysis, taxonomic profiling, functional annotation, and data visualization.

By the end of the course, participants will have the confidence to approach metagenomic datasets and understand their relevance to scientific challenges in microbiology, ecology, and beyond. The grade will be based on a course grade (65%) from weekly tasks and exercises and a final report (35%) due one week after the course (at the latest). S2: 100% oral exam for participants who did not pass S1. It will cover the lectures and key metagenomic concepts from the course.

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
AI meets IA (infectious agents): accelerating research with critical thinking	3	Semestre 1	6	12							

AI meets IA (infectious agents): accelerating research with critical thinking

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 6

Travaux dirigés : 12

Projet tutoré 9

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students should have a solid foundation in molecular and cellular biology, microbiology, or related biomedical sciences. Familiarity with basic data analysis or biostatistics concepts is advantageous but not mandatory. No prior programming experience is required; emphasis will be placed on conceptual understanding and interpretation of AI-based research in a biological context.

Programme / plan / contenus

This teaching unit introduces students to the interdisciplinary interface between artificial intelligence (AI) and infectious disease research. It explores how AI and machine learning approaches are transforming our understanding of pathogen biology, host-pathogen interactions, and epidemiological dynamics. Students will examine how computational tools are applied to areas such as genomic analysis, diagnostics, drug discovery, and outbreak prediction.

The course begins with a seminar providing an overview of the main AI tools and concepts relevant to biological and biomedical research, designed to ensure a common foundation among participants. Building on this introduction, students will undertake an applied analytical project, either individually or in small groups, using AI-based approaches to analyze scientific literature or experimental datasets. Projects will be tutored by experts in virology, microbiology, or computational science, allowing students to receive personalized guidance throughout their work.

The course emphasizes critical thinking and scientific rigor rather than technical coding skills. Students will learn to assess the potential and limitations of AI methods, interpret outcomes in a biological context, and

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Microbial Interactions	3	Semestre 1	20								
■											

Microbial Interactions

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Microbiology, Biochemistry, Molecular Biology

Programme / plan / contenus

This teaching unit aims to present different types of possible interactions involving microorganisms. The characteristics of biofilm formation will be presented. In the context of an interaction between individuals of the same species, it is relevant to understand the molecular bases of cell communication pathways, such as quorum-sensing, in particular in bacteria. Mutualism and parasitism relationships will be presented with different examples involving bacteria, fungi, or protists whose hosts are plants, animals (insect, human) or even other microorganisms.

Objectifs d'apprentissage

- Acquire a solid and integrated knowledge of microbiology through microbial interactions. - Develop the ability to identify, integrate and critically analyze key information from specialized scientific literature.

Organisation générale et modalités pédagogiques

The teaching unit takes the form of seminars, which are structured around themes related to microorganisms and the environment, led by lecturer-researchers and invited expert researchers.

Nature de l'évaluation

Evaluation Terminale

Elective teaching units of the Virology track

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
----------	------	----------	-------	----	----	--------------	--------------	-----------	---------------	--------	---------

[Initiation to statistics using R \(MOOC\)](#) 3 Semestre 1 5



Initiation to statistics using R (MOOC)

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Objectifs d'apprentissage

The M2 of Fundamental Microbiology offers students the opportunity to validate a bioinformatics course introducing statistics using the free software R.

Organisation générale et modalités pédagogiques

Program: Data analysis using R, probabilities, statistical inference, linear regression, etc...

An exam organized by the M2 pedagogical team will validate this training.

Students can follow the MOOC for free either in French or in English.

Nature de l'évaluation

Evaluation Continue non Intégrale

[Frontiers in Microbial Systems](#) 3 Semestre 1 20 5



Frontiers in Microbial Systems

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Knowledge in molecular and cellular biology (gene regulation, organization of prokaryotic and eukaryotic cells, signaling, etc...) and principles of evolution.

Students are expected to master classical concepts in bacterial genetics to be able to follow the lectures.

Students have to apply to be selected for the teaching unit.

Objectifs d'apprentissage

Introduction to microbial systems and their diversity. The development of diverse and recent approaches (genome-wide studies, single cell analysis, biophysics, modelling) has revealed key aspects of microbial biology and ecology, which will be illustrated throughout this course. The theme changes every year.

Organisation générale et modalités pédagogiques

The program varies every year.

Example of themes:

Bacterial physiology in the environment

This theme will introduce mechanisms controlling bacterial cell structure and cycle, bacterial adaptation, motion, stress responses and differentiation in response to environmental cues. The 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

This theme will explore how bacteria adapt and co-evolve as part of ecosystems, and how they contribute to the shaping of 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 discussed in the context of the "One Health" approach.



Practical course of integrative microbiology

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Travaux pratiques : 65

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Molecular Biology, Biochemistry, Cell Biology and
General Microbiology

Objectifs d'apprentissage

This teaching unit aims to familiarize students with the most modern techniques to address a scientific issue in Microbiology.

Organisation générale et modalités pédagogiques

The training is designed to provide students with good technical and scientific expertise in the development of protocols and analysis of the results so as to best prepare them for their integration into the S4 semester. This training will be provided by the staff of one or more research teams from the Paris-Saclay Research Institute hosting the practical course. The backing of this teaching unit to laboratories and themes of Paris-Saclay Research Institutes will allow students to learn the latest techniques and to interact with researchers. The duration of this course will be 2 weeks in a Research Institute of Paris-Saclay.

Modalités pédagogiques particulières

Oral examination (x 0.5) and written examination (0.5)
(oral presentation and written examination in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

[UE1 libre à 3
ECTS](#)



UE1 libre à 3 ECTS

ECTS : 3

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

[Environmental](#)

[microbial](#)

[biotechnology](#)

6

Semestre 1 42

1

3

4



Environmental microbial biotechnology

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 42

Travaux pratiques : 3

Travaux dirigés : 1

Projet tutoré 0

Projet : 4

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students should have a solid foundation in microbiology (microbial growth, metabolism, microbial ecology) and biochemistry (metabolic cycles, enzymatic reactions).

Programme / plan / contenus

The program will cover:

- Principles and challenges of biological treatment of solid and liquid waste;
- Key solid waste treatment processes (anaerobic digestion, composting, bioactive storage, etc.) and liquid waste processes (wastewater treatment plants for carbon, nitrogen, and phosphorus removal);
- Microbial processes and microbial populations involved;
- Recent research approaches to better understand the biological functioning of these systems, including isotopic chemistry, molecular biology, modern imaging techniques, and metaproteomics, as well as their implications for bioprocess engineering.

The goal is to enable a structural and functional understanding of complex natural ecosystems in order to reproduce and optimize them in controlled processes.

Evaluation: Assessment will be based on a critical review of a scientific publication related to the course topic, presented orally in pairs in English.

Objectifs d'apprentissage

Bioprocesses such as wastewater treatment plants or waste anaerobic digesters enable the intensification of natural microbial processes involved in organic matter recycling. The need to optimize the quality of effluents released into the environment has led to the development of engineering approaches for carbon, nitrogen, and

Medico-
Pharmaceutical
Applications of
Microbial
Biodiversity

6

Semestre 1 42

8

Medico-Pharmaceutical Applications of Microbial Biodiversity

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 42

Travaux dirigés : 8

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students wishing to enroll in the *MPAMB Teaching Unit* must:

- Hold a first year of a Master's degree in Health Biology, Cellular and Molecular Biology, or an equivalent Master's degree / engineering curriculum in Biology and Biotechnologies, or hold a degree in Pharmacy or Medicine.
- Possess solid knowledge in microbiology and virology (biodiversity, genetics, physiology), genomics, biochemistry, molecular and cellular biology, as well as in fundamental sciences (Chemistry, Physics, Mathematics, and Computer Science).
- Have sufficient proficiency in English to follow all courses, which will be taught entirely in that language.

Programme / plan / contenus

Topics covered include:

- R&D strategies in the agri-food, pharmaceutical, and service industries
- Intellectual and industrial property tools (patents, trademarks)
- Technology transfer and valorization in life sciences
- Technology readiness levels (TRLs)
- Artificial intelligence for health sciences
- Cellular models for the production of recombinant proteins and therapeutic bioproducts
- Quality of pharmaceutical waters
- Control of infectious risks in biopharmaceutical products
- Analytical methods in microbiology: traditional and recent rapid technologies
- Perspectives in precision and personalized medicine
- The CRISPR-Cas system in *Clostridioides difficile*



Molecular and cellular microbiology

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

A solid background in the molecular and cellular biology of eukaryotic and prokaryotic cells is required.

Programme / plan / contenus

Program Overview

- Bacterial cell wall organization
- Cell morphology and division in bacteria and archaea
- DNA transfer mechanisms
- Life and death in the bacterial world
- RNA-based regulation

Objectifs d'apprentissage

This teaching unit aims to update students' knowledge on the latest advances in microbial cell biology.

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

- Understand key concepts in molecular and cellular microbiology.
- Critically analyze and interpret scientific literature in the field.

Organisation générale et modalités pédagogiques

This teaching unit will cover cytoskeleton organization, membrane dynamics, cell cycle control, stress responses, cell polarity, differentiation, aging, and programmed cell death in unicellular organisms.

Additional topics may be covered depending on current research trends, with some sessions led by students based on selected scientific articles.

The course is delivered over a single intensive week, with two lectures or seminars per day. Dedicated time is provided for the preparation of the oral presentation, which takes place two weeks after the end of the teaching period.

The written examination is scheduled at the end of the semester.

[Introduction to
Metagenomics](#)

3

Semestre 1 10

10



Introduction to Metagenomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Basic knowledge in microbiology with high interest in the biology of bacteria, phages, and plasmids interacting in communities and in interactions with pluricellular hosts. Strong interest in genomics, big data analysis, and bioinformatics. A mobile, personal computer is required for this course (as it cannot be provided).

Objectifs d'apprentissage

This course provides a basic and comprehensive introduction to the dynamic field of metagenomics, which is essential for understanding microbiome-host (holobiont) interactions. Participants will explore diverse topics such as the human gut microbiome, plant-microbe interactions, and the roles of viruses (the ‘virome’) within microbiomes. Metagenomics is key in advancing our understanding of microbial diversity, ecosystem dynamics, and their implications for health, agriculture, and the environment.

Organisation générale et modalités pédagogiques

Lectures will be given by experts in the field, and participants will analyze real-world datasets by gaining hands-on experience with R (RStudio), computing clusters, and command-line tools. The approaches will include data pre-processing, community analysis, taxonomic profiling, functional annotation, and data visualization.

By the end of the course, participants will have the confidence to approach metagenomic datasets and understand their relevance to scientific challenges in microbiology, ecology, and beyond. The grade will be based on a course grade (65%) from weekly tasks and exercises and a final report (35%) due one week after the course (at the latest). S2: 100% oral exam for participants who did not pass S1. It will cover the lectures and key metagenomic concepts from the course.

Nature de l'évaluation

Evaluation Continue non Intégrale

Antiviral Defense
Systems in
Prokaryotes: from
Molecular Battles
to Biotechnological
Applications

3

Semestre 1 20

Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Completion of introductory courses in Molecular Biology and Microbiology

Objectifs d'apprentissage

The past decade has seen an **explosion** in the discovery of prokaryotic antiviral defenses—far beyond restriction-modification and CRISPR—revealing a hidden world of molecular innovation. This course explores the evolutionary arms race between prokaryotes and their viruses, uncovering how these ancient systems not only shape microbial ecosystems but also share striking parallels with eukaryotic innate immunity. From cyclic nucleotide signaling to phage abortive infection, these mechanisms offer a window into the origins of immunity itself and challenge our understanding of genetic conflict. Join us to dive into the cutting edge of microbial immunity, where ancient battles fuel modern breakthroughs.

Organisation générale et modalités pédagogiques

In groups of 2–3, students analyze a course-related article and present it on Friday, followed by Q&A with an opposing group. Grades are based on **presentation quality, article analysis, responses to questions, and participation.**

Nature de l'évaluation

Evaluation Continue non Intégrale

[AI meets IA](#)

[\(infectious agents\):](#)

[accelerating](#)

3

Semestre 1 6

12

[research with](#)

[critical thinking](#)



AI meets IA (infectious agents): accelerating research with critical thinking

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 6

Travaux dirigés : 12

Projet tutoré 9

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students should have a solid foundation in molecular and cellular biology, microbiology, or related biomedical sciences. Familiarity with basic data analysis or biostatistics concepts is advantageous but not mandatory. No prior programming experience is required; emphasis will be placed on conceptual understanding and interpretation of AI-based research in a biological context.

Programme / plan / contenus

This teaching unit introduces students to the interdisciplinary interface between artificial intelligence (AI) and infectious disease research. It explores how AI and machine learning approaches are transforming our understanding of pathogen biology, host–pathogen interactions, and epidemiological dynamics. Students will examine how computational tools are applied to areas such as genomic analysis, diagnostics, drug discovery, and outbreak prediction.

The course begins with a seminar providing an overview of the main AI tools and concepts relevant to biological and biomedical research, designed to ensure a common foundation among participants. Building on this introduction, students will undertake an applied analytical project, either individually or in small groups, using AI-based approaches to analyze scientific literature or experimental datasets. Projects will be tutored by experts in virology, microbiology, or computational science, allowing students to receive personalized guidance throughout their work.

The course emphasizes critical thinking and scientific rigor rather than technical coding skills. Students will learn to assess the potential and limitations of AI methods, interpret outcomes in a biological context, and evaluate the reliability and ethical implications of data-driven research. Through lectures, interactive discussions, and



Microbial Interactions

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Microbiology, Biochemistry, Molecular Biology

Programme / plan / contenus

This teaching unit aims to present different types of possible interactions involving microorganisms. The characteristics of biofilm formation will be presented. In the context of an interaction between individuals of the same species, it is relevant to understand the molecular bases of cell communication pathways, such as quorum-sensing, in particular in bacteria. Mutualism and parasitism relationships will be presented with different examples involving bacteria, fungi, or protists whose hosts are plants, animals (insect, human) or even other microorganisms.

Objectifs d'apprentissage

- Acquire a solid and integrated knowledge of microbiology through microbial interactions. - Develop the ability to identify, integrate and critically analyze key information from specialized scientific literature.

Organisation générale et modalités pédagogiques

The teaching unit takes the form of seminars, which are structured around themes related to microorganisms and the environment, led by lecturer-researchers and invited expert researchers.

Nature de l'évaluation

Evaluation Terminale

Internship - Training through Research

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
----------	------	----------	-------	----	----	--------------	--------------	-----------	---------------	--------	---------

Projet de recherche / Scientific project

ECTS : 3

Semestre calendaire : Semestre 2

Détail du volume horaire

Travaux dirigés : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

General Microbiology, Molecular and Cell Biology,
Genetics, Biochemistry

Objectifs d'apprentissage

The student will carry out an investigation through bibliographic research and interaction with the host team on the research subject that he/she will conduct during his/her M2 internship. This preliminary work will aim to present the scientific context and the issues associated with its research subject as well as the methods that will be implemented to answer the question (s) asked.

Organisation générale et modalités pédagogiques

Session 1 & Session 2 : F = 0.5 x report + 0.5 x EO
(report and oral presentation in French or in English depending on the student's choice)

Bibliographie

Scientific articles on the research subject

Nature de l'évaluation

Evaluation Continue non Intégrale



Stage en laboratoire / Lab training

ECTS : 27

Semestre calendaire : Semestre 2

Détail du volume horaire

Travaux dirigés : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

General Microbiology, Molecular and Cell Biology,
Genetics, Biochemistry

Objectifs d'apprentissage

The laboratory internship corresponds to a qualifying training through a 6-month research activity in a field related to Microbiology. It allows the student to be trained in experimental techniques but also in project writing and oral scientific communication. The M2 supervisors identify internship proposals with all the support laboratories attached in particular to the **Paris-Saclay research institutes, in other French Research institutes, or abroad.**

Organisation générale et modalités pédagogiques

At the end of the lab training, the student writes a thesis describing the research activities carried out and the results obtained during the internship. The report is accompanied by an oral presentation to the M2 Scientific and Pedagogical Committee, during which the student presents the key elements of his/her report, the work done and the reflection carried out during his internship.

Examinations: Report and oral presentation evaluation

Session 1 and Session 2: $F = 0.4 \times \text{report} + 0.6 \times \text{EO}$

(report and oral presentation in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

Molecular and Cellular Microbiology track

Core curriculum

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
----------	------	----------	-------	----	----	--------------	--------------	-----------	---------------	--------	---------

[Initiation to data exploration with R](#) 3 Semestre 1 10 10
■

Initiation to data exploration with R

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Objectifs d'apprentissage

This course introduces students to R software for analyzing biological datasets generated by high-throughput omic technologies. Through a blend of theory and hands-on practice, students will learn to use R for data exploration, analysis, and visualization in biological research.

Organisation générale et modalités pédagogiques

The course is structured around interactive teaching days, featuring practical training for direct application of concepts, live and pair programming sessions to encourage collaboration and problem-solving, and a project tailored to each student's initial skill level, ensuring personalized growth and mastery. To reinforce learning, self-assessment tests are provided. Evaluation: Continuous assessment, including project evaluation.

Nature de l'évaluation

Evaluation Continue non Intégrale

[Cellular innovations and new concepts in synthetic microbiology](#) 3 Semestre 1 20



Cellular innovations and new concepts in synthetic microbiology

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

M1 level in Molecular biology

Objectifs d'apprentissage

This course aims to establish the key concepts underlying recent advances in the field of synthetic microbiology.

Organisation générale et modalités pédagogiques

Through examples of fundamental and applied issues, the conferences will illustrate how and why synthetic biology approaches can contribute to understanding how living organisms work, generate microbial strains that are improved in terms of efficacy and/or safety and open up new fields of research in biology. Conferences on history and ethics surrounding these fields of investigation will address the question of the positioning of synthetic biology in society and in the evolution of research. Students will be evaluated on the synthetic biology project they have developed (10-15 min oral + written report). The project will be evaluated on its originality, coherence/relevance, feasibility and mastery of the scientific context around the issue raised by the student.

Session 1 & Session 2 : F = 0.5 x report + 0.5 x oral presentation (the report corresponds to the synthetic biology project; report and oral presentation in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

[Practical course
of integrative
microbiology](#)

6

Semestre 1

5

65



Practical course of integrative microbiology

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Travaux pratiques : 65

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Molecular Biology, Biochemistry, Cell Biology and General Microbiology

Objectifs d'apprentissage

This teaching unit aims to familiarize students with the most modern techniques to address a scientific issue in Microbiology.

Organisation générale et modalités pédagogiques

The training is designed to provide students with good technical and scientific expertise in the development of protocols and analysis of the results so as to best prepare them for their integration into the S4 semester. This training will be provided by the staff of one or more research teams from the Paris-Saclay Research Institute hosting the practical course. The backing of this teaching unit to laboratories and themes of Paris-Saclay Research Institutes will allow students to learn the latest techniques and to interact with researchers. The duration of this course will be 2 weeks in a Research Institute of Paris-Saclay.

Modalités pédagogiques particulières

Oral examination (x 0.5) and written examination (0.5)
(oral presentation and written examination in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

[Functional Genomics](#)

3

Semestre 1 20

5



Functional Genomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

M1 level in genomics, genetics and molecular biology

Organisation générale et modalités pédagogiques

This teaching unit explores the latest advances and innovative concepts in functional genomics. Led by leading experts in the field, the course will cover cutting-edge scientific developments in comparative genomics, metagenomics, transcriptomics, proteomics, and their applications.

Key objectives:

- Bridge the gap between scientific questions and the most effective methodologies to address them.
- Foster critical discussions on how global approaches in genomics are reshaping our understanding of gene function and the genome 'dark matter'.

Interactive learning:

- Roundtable discussions between students and researchers to explore the impact of emerging concepts in genomics.
- A one-day mini-symposium where students present their own reviews on self-selected themes, encouraging active participation and deeper engagement with the material

Nature de l'évaluation

Evaluation Continue non Intégrale

[Molecular and cellular microbiology](#)

3

Semestre 1 25



Molecular and cellular microbiology

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 25

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

A solid background in the molecular and cellular biology of eukaryotic and prokaryotic cells is required.

Programme / plan / contenus

Program Overview

- Bacterial cell wall organization
- Cell morphology and division in bacteria and archaea
- DNA transfer mechanisms
- Life and death in the bacterial world
- RNA-based regulation

Objectifs d'apprentissage

This teaching unit aims to update students' knowledge on the latest advances in microbial cell biology.

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

- Understand key concepts in molecular and cellular microbiology.
- Critically analyze and interpret scientific literature in the field.

Organisation générale et modalités pédagogiques

This teaching unit will cover cytoskeleton organization, membrane dynamics, cell cycle control, stress responses, cell polarity, differentiation, aging, and programmed cell death in unicellular organisms.

Additional topics may be covered depending on current research trends, with some sessions led by students based on selected scientific articles.

The course is delivered over a single intensive week, with two lectures or seminars per day. Dedicated time is provided for the preparation of the oral presentation, which takes place two weeks after the end of the teaching period.

The written examination is scheduled at the end of the semester.

Elective teaching units in the field of microbial interactions for MCM track

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
<u>Introduction to Metagenomics</u>	3	Semestre 1	10	10							

Introduction to Metagenomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Basic knowledge in microbiology with high interest in the biology of bacteria, phages, and plasmids interacting in communities and in interactions with pluricellular hosts. Strong interest in genomics, big data analysis, and bioinformatics. A mobile, personal computer is required for this course (as it cannot be provided).

Objectifs d'apprentissage

This course provides a basic and comprehensive introduction to the dynamic field of metagenomics, which is essential for understanding microbiome-host (holobiont) interactions. Participants will explore diverse topics such as the human gut microbiome, plant-microbe interactions, and the roles of viruses (the 'virome') within microbiomes. Metagenomics is key in advancing our understanding of microbial diversity, ecosystem dynamics, and their implications for health, agriculture, and the environment.

Organisation générale et modalités pédagogiques

Lectures will be given by experts in the field, and participants will analyze real-world datasets by gaining hands-on experience with R (RStudio), computing clusters, and command-line tools. The approaches will include data pre-processing, community analysis, taxonomic profiling, functional annotation, and data visualization.

By the end of the course, participants will have the confidence to approach metagenomic datasets and understand their relevance to scientific challenges in microbiology, ecology, and beyond. The grade will be based on a course grade (65%) from weekly tasks and exercises and a final report (35%) due one week after the course (at the latest). S2: 100% oral exam for participants who did not pass S1. It will cover the lectures and key metagenomic concepts from the course.

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications	3	Semestre 1	20								

Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Completion of introductory courses in Molecular Biology and Microbiology

Objectifs d'apprentissage

The past decade has seen an **explosion** in the discovery of prokaryotic antiviral defenses—far beyond restriction-modification and CRISPR—revealing a hidden world of molecular innovation. This course explores the evolutionary arms race between prokaryotes and their viruses, uncovering how these ancient systems not only shape microbial ecosystems but also share striking parallels with eukaryotic innate immunity. From cyclic nucleotide signaling to phage abortive infection, these mechanisms offer a window into the origins of immunity itself and challenge our understanding of genetic conflict. Join us to dive into the cutting edge of microbial immunity, where ancient battles fuel modern breakthroughs.

Organisation générale et modalités pédagogiques

In groups of 2–3, students analyze a course-related article and present it on Friday, followed by Q&A with an opposing group. Grades are based on **presentation quality, article analysis, responses to questions, and participation.**

Nature de l'évaluation

Evaluation Continue non Intégrale

[Microbial Interactions](#)

3

Semestre 1 20

Microbial Interactions

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Microbiology, Biochemistry, Molecular Biology

Programme / plan / contenus

This teaching unit aims to present different types of possible interactions involving microorganisms. The characteristics of biofilm formation will be presented. In the context of an interaction between individuals of the same species, it is relevant to understand the molecular bases of cell communication pathways, such as quorum-sensing, in particular in bacteria. Mutualism and parasitism relationships will be presented with different examples involving bacteria, fungi, or protists whose hosts are plants, animals (insect, human) or even other microorganisms.

Objectifs d'apprentissage

- Acquire a solid and integrated knowledge of microbiology through microbial interactions. - Develop the ability to identify, integrate and critically analyze key information from specialized scientific literature.

Organisation générale et modalités pédagogiques

The teaching unit takes the form of seminars, which are structured around themes related to microorganisms and the environment, led by lecturer-researchers and invited expert researchers.

Nature de l'évaluation

Evaluation Terminale

Elective teaching units of the track MCM

[Initiation to statistics using R \(MOOC\)](#) 3 Semestre 1 5



Initiation to statistics using R (MOOC)

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Objectifs d'apprentissage

The M2 of Fundamental Microbiology offers students the opportunity to validate a bioinformatics course introducing statistics using the free software R.

Organisation générale et modalités pédagogiques

Program: Data analysis using R, probabilities, statistical inference, linear regression, etc...

An exam organized by the M2 pedagogical team will validate this training.

Students can follow the MOOC for free either in French or in English.

Nature de l'évaluation

Evaluation Continue non Intégrale

[Frontiers in Microbial Systems](#) 3 Semestre 1 20 5

Frontiers in Microbial Systems

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 5

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Knowledge in molecular and cellular biology (gene regulation, organization of prokaryotic and eukaryotic cells, signaling, etc...) and principles of evolution.

Students are expected to master classical concepts in bacterial genetics to be able to follow the lectures.

Students have to apply to be selected for the teaching unit.

Objectifs d'apprentissage

Introduction to microbial systems and their diversity. The development of diverse and recent approaches (genome-wide studies, single cell analysis, biophysics, modelling) has revealed key aspects of microbial biology and ecology, which will be illustrated throughout this course. The theme changes every year.

Organisation générale et modalités pédagogiques

The program varies every year.

Example of themes:

Bacterial physiology in the environment

This theme will introduce mechanisms controlling bacterial cell structure and cycle, bacterial adaptation, motion, stress responses and differentiation in response to environmental cues. The 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

This theme will explore how bacteria adapt and co-evolve as part of ecosystems, and how they contribute to the shaping of 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

[UE1 libre à 3 ECTS](#)

3

Semestre 1



UE1 libre à 3 ECTS

ECTS : 3

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

[Environmental](#)

[microbial](#)

6

Semestre 1 42

1

3

4

[biotechnology](#)



Environmental microbial biotechnology

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 42

Travaux pratiques : 3

Travaux dirigés : 1

Projet tutoré 0

Projet : 4

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students should have a solid foundation in microbiology (microbial growth, metabolism, microbial ecology) and biochemistry (metabolic cycles, enzymatic reactions).

Programme / plan / contenus

The program will cover:

- Principles and challenges of biological treatment of solid and liquid waste;
- Key solid waste treatment processes (anaerobic digestion, composting, bioactive storage, etc.) and liquid waste processes (wastewater treatment plants for carbon, nitrogen, and phosphorus removal);
- Microbial processes and microbial populations involved;
- Recent research approaches to better understand the biological functioning of these systems, including isotopic chemistry, molecular biology, modern imaging techniques, and metaproteomics, as well as their implications for bioprocess engineering.

The goal is to enable a structural and functional understanding of complex natural ecosystems in order to reproduce and optimize them in controlled processes.

Evaluation: Assessment will be based on a critical review of a scientific publication related to the course topic, presented orally in pairs in English.

Objectifs d'apprentissage

Bioprocesses such as wastewater treatment plants or waste anaerobic digesters enable the intensification of natural microbial processes involved in organic matter recycling. The need to optimize the quality of effluents released into the environment has led to the development of engineering approaches for carbon, nitrogen, and

Medico-
Pharmaceutical
Applications of
Microbial
Biodiversity

6

Semestre 1 42

8

Medico-Pharmaceutical Applications of Microbial Biodiversity

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 42

Travaux dirigés : 8

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students wishing to enroll in the *MPAMB Teaching Unit* must:

- Hold a first year of a Master's degree in Health Biology, Cellular and Molecular Biology, or an equivalent Master's degree / engineering curriculum in Biology and Biotechnologies, or hold a degree in Pharmacy or Medicine.
- Possess solid knowledge in microbiology and virology (biodiversity, genetics, physiology), genomics, biochemistry, molecular and cellular biology, as well as in fundamental sciences (Chemistry, Physics, Mathematics, and Computer Science).
- Have sufficient proficiency in English to follow all courses, which will be taught entirely in that language.

Programme / plan / contenus

Topics covered include:

- R&D strategies in the agri-food, pharmaceutical, and service industries
- Intellectual and industrial property tools (patents, trademarks)
- Technology transfer and valorization in life sciences
- Technology readiness levels (TRLs)
- Artificial intelligence for health sciences
- Cellular models for the production of recombinant proteins and therapeutic bioproducts
- Quality of pharmaceutical waters
- Control of infectious risks in biopharmaceutical products
- Analytical methods in microbiology: traditional and recent rapid technologies
- Perspectives in precision and personalized medicine
- The CRISPR-Cas system in *Clostridioides difficile*

[Introduction to
Metagenomics](#)

3

Semestre 1 10

10



Introduction to Metagenomics

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 10

Travaux dirigés : 10

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Basic knowledge in microbiology with high interest in the biology of bacteria, phages, and plasmids interacting in communities and in interactions with pluricellular hosts. Strong interest in genomics, big data analysis, and bioinformatics. A mobile, personal computer is required for this course (as it cannot be provided).

Objectifs d'apprentissage

This course provides a basic and comprehensive introduction to the dynamic field of metagenomics, which is essential for understanding microbiome-host (holobiont) interactions. Participants will explore diverse topics such as the human gut microbiome, plant-microbe interactions, and the roles of viruses (the ‘virome’) within microbiomes. Metagenomics is key in advancing our understanding of microbial diversity, ecosystem dynamics, and their implications for health, agriculture, and the environment.

Organisation générale et modalités pédagogiques

Lectures will be given by experts in the field, and participants will analyze real-world datasets by gaining hands-on experience with R (RStudio), computing clusters, and command-line tools. The approaches will include data pre-processing, community analysis, taxonomic profiling, functional annotation, and data visualization.

By the end of the course, participants will have the confidence to approach metagenomic datasets and understand their relevance to scientific challenges in microbiology, ecology, and beyond. The grade will be based on a course grade (65%) from weekly tasks and exercises and a final report (35%) due one week after the course (at the latest). S2: 100% oral exam for participants who did not pass S1. It will cover the lectures and key metagenomic concepts from the course.

Nature de l'évaluation

Evaluation Continue non Intégrale

Antiviral Defense
Systems in
Prokaryotes: from
Molecular Battles
to Biotechnological
Applications

3

Semestre 1 20

Antiviral Defense Systems in Prokaryotes: from Molecular Battles to Biotechnological Applications

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Completion of introductory courses in Molecular Biology and Microbiology

Objectifs d'apprentissage

The past decade has seen an **explosion** in the discovery of prokaryotic antiviral defenses—far beyond restriction-modification and CRISPR—revealing a hidden world of molecular innovation. This course explores the evolutionary arms race between prokaryotes and their viruses, uncovering how these ancient systems not only shape microbial ecosystems but also share striking parallels with eukaryotic innate immunity. From cyclic nucleotide signaling to phage abortive infection, these mechanisms offer a window into the origins of immunity itself and challenge our understanding of genetic conflict. Join us to dive into the cutting edge of microbial immunity, where ancient battles fuel modern breakthroughs.

Organisation générale et modalités pédagogiques

In groups of 2–3, students analyze a course-related article and present it on Friday, followed by Q&A with an opposing group. Grades are based on **presentation quality, article analysis, responses to questions, and participation.**

Nature de l'évaluation

Evaluation Continue non Intégrale

[AI meets IA](#)

[\(infectious agents\):](#)

[accelerating](#)

3

Semestre 1 6

12

[research with](#)

[critical thinking](#)



AI meets IA (infectious agents): accelerating research with critical thinking

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 6

Travaux dirigés : 12

Projet tutoré 9

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Students should have a solid foundation in molecular and cellular biology, microbiology, or related biomedical sciences. Familiarity with basic data analysis or biostatistics concepts is advantageous but not mandatory. No prior programming experience is required; emphasis will be placed on conceptual understanding and interpretation of AI-based research in a biological context.

Programme / plan / contenus

This teaching unit introduces students to the interdisciplinary interface between artificial intelligence (AI) and infectious disease research. It explores how AI and machine learning approaches are transforming our understanding of pathogen biology, host–pathogen interactions, and epidemiological dynamics. Students will examine how computational tools are applied to areas such as genomic analysis, diagnostics, drug discovery, and outbreak prediction.

The course begins with a seminar providing an overview of the main AI tools and concepts relevant to biological and biomedical research, designed to ensure a common foundation among participants. Building on this introduction, students will undertake an applied analytical project, either individually or in small groups, using AI-based approaches to analyze scientific literature or experimental datasets. Projects will be tutored by experts in virology, microbiology, or computational science, allowing students to receive personalized guidance throughout their work.

The course emphasizes critical thinking and scientific rigor rather than technical coding skills. Students will learn to assess the potential and limitations of AI methods, interpret outcomes in a biological context, and evaluate the reliability and ethical implications of data-driven research. Through lectures, interactive discussions, and



Microbial Interactions

ECTS : 3

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Microbiology, Biochemistry, Molecular Biology

Programme / plan / contenus

This teaching unit aims to present different types of possible interactions involving microorganisms. The characteristics of biofilm formation will be presented. In the context of an interaction between individuals of the same species, it is relevant to understand the molecular bases of cell communication pathways, such as quorum-sensing, in particular in bacteria. Mutualism and parasitism relationships will be presented with different examples involving bacteria, fungi, or protists whose hosts are plants, animals (insect, human) or even other microorganisms.

Objectifs d'apprentissage

- Acquire a solid and integrated knowledge of microbiology through microbial interactions. - Develop the ability to identify, integrate and critically analyze key information from specialized scientific literature.

Organisation générale et modalités pédagogiques

The teaching unit takes the form of seminars, which are structured around themes related to microorganisms and the environment, led by lecturer-researchers and invited expert researchers.

Nature de l'évaluation

Evaluation Terminale

[Advanced Cellular
and Molecular
Virology of
Eukaryotes](#)

6

Semestre 1 20

20



Advanced Cellular and Molecular Virology of Eukaryotes

ECTS : 6

Semestre calendaire : Semestre 1

Détail du volume horaire

Cours magistraux : 20

Travaux dirigés : 20

Projet tutoré 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

This teaching unit is designed for students with a **strong foundation in molecular and cellular biology**.

Participants are expected to be familiar with fundamental concepts in cell structure and function, nucleic acid biology, protein synthesis, and basic immunology. Prior exposure to **general microbiology and/or virology is recommended** to facilitate understanding of viral replication strategies and host–virus interactions. Students are expected to be **comfortable reading and interpreting primary scientific literature** and have familiarity with experimental techniques commonly used in molecular and cellular biology (cell culture/transfection, electrophoresis, immunoblotting, PCR/qPCR, immunostaining, microscopy, flow cytometry).

Programme / plan / contenus

This teaching unit aims to provide Master 2 students with a **strong and detailed knowledge of the molecular and cellular mechanisms that govern the replication cycles of viruses** infecting eukaryotic cells. Emphasis will be placed on the **structure and function of viral components, virus–host interactions**, and the application of **cutting-edge technologies** that have shaped current knowledge in the field.

Through a series of **lectures delivered by expert researchers** and complemented by **interactive discussions and student presentations**, participants will explore fundamental and emerging concepts in molecular virology.

Topics will include, but are not limited to:

- Structure and function of viral fusion glycoproteins
- Mechanisms of virus entry into target cells
- Structure and assembly of viruses
- Hijacking of cellular machineries for the expression and replication of viral genomes

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Projet de recherche / Scientific project	3	Semestre 2		20							

Projet de recherche / Scientific project

ECTS : 3

Semestre calendaire : Semestre 2

Détail du volume horaire

Travaux dirigés : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

General Microbiology, Molecular and Cell Biology, Genetics, Biochemistry

Objectifs d'apprentissage

The student will carry out an investigation through bibliographic research and interaction with the host team on the research subject that he/she will conduct during his/her M2 internship. This preliminary work will aim to present the scientific context and the issues associated with its research subject as well as the methods that will be implemented to answer the question (s) asked.

Organisation générale et modalités pédagogiques

Session 1 & Session 2 : F = 0.5 x report + 0.5 x EO (report and oral presentation in French or in English depending on the student's choice)

Bibliographie

Scientific articles on the research subject

Nature de l'évaluation

Evaluation Continue non Intégrale

Stage en laboratoire / Lab training	27	Semestre 2	20
---	----	------------	----

Stage en laboratoire / Lab training

ECTS : 27

Semestre calendaire : Semestre 2

Détail du volume horaire

Travaux dirigés : 20

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

General Microbiology, Molecular and Cell Biology,
Genetics, Biochemistry

Objectifs d'apprentissage

The laboratory internship corresponds to a qualifying training through a 6-month research activity in a field related to Microbiology. It allows the student to be trained in experimental techniques but also in project writing and oral scientific communication. The M2 supervisors identify internship proposals with all the support laboratories attached in particular to the **Paris-Saclay research institutes, in other French Research institutes, or abroad.**

Organisation générale et modalités pédagogiques

At the end of the lab training, the student writes a thesis describing the research activities carried out and the results obtained during the internship. The report is accompanied by an oral presentation to the M2 Scientific and Pedagogical Committee, during which the student presents the key elements of his/her report, the work done and the reflection carried out during his internship.

Examinations: Report and oral presentation evaluation

Session 1 and Session 2: $F = 0.4 \times \text{report} + 0.6 \times \text{EO}$

(report and oral presentation in French or in English depending on the student's choice)

Nature de l'évaluation

Evaluation Continue non Intégrale

Lieu(x) d'enseignement

GIF SUR YVETTE

PARIS 15
JOUY EN JOSAS
VERSAILLES

Partenaire(s) académique(s) de la formation

Collège de France

Contact(s)

- **Solène FLORENTIN**

secrétariat pédagogique
- **Olga SOUTOURINA**

PR
- **Tamara BASTA-LE BERRE**

MCF
- **Alessia ZAMBORLINI**

PR

<http://www.universite-paris-saclay.fr/formation/master/microbiologie/m2-microbiologie-fondamentale>