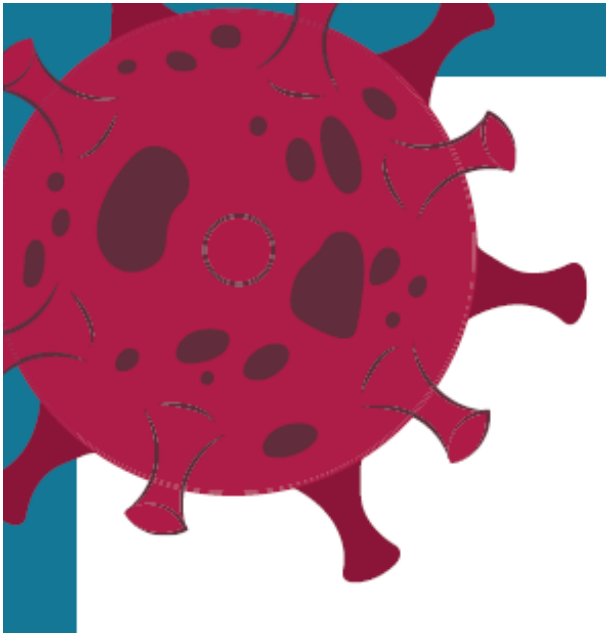




Master Molecular and Cellular Biology (BMC)

Emerging Infectious Diseases

2026-2027



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General presentation

Early detection and preparation to epidemics of emerging infectious diseases are essential to the reactive implementation of effective measures to reduce their impact. An educational programme of excellence in the field of (re)emerging pathogens is the key to raise the major challenges that future generations will face.

In Master 2 Molecular and Cellular Biology – Emerging Infectious Diseases courses (MIE), students from different and diverse backgrounds – medicine, pharmacy, science, veterinary and engineering schools – will follow a transdisciplinary programme which offers an education in the biology of emerging pathogens, epidemiology, veterinary science, ecology, evolutionary biology and socio-anthropology.

Students take core courses that enable them to build a solid foundation of knowledge regarding the One Health approach to emerging infectious diseases. They can then choose additional modules of their choice (“From the Field”, innovation, vaccines, monoclonal antibodies, ecology, circulation of infectious agents and risk control, antibiotic resistance, infection modelling, surveillance or global health, etc.).

Customized Master 2 internships highly encouraging multidisciplinary – two internships, interface project, internship and tutored project – will rely on the diversity of the laboratories of excellence affiliated to the Graduate School, offering a unique environment to combine fundamental and translational research in: virology, microbiology, epidemiology and modelling, social sciences.

* UE exclusively in English

**TRONC COMMUN
18 ECTS**

- * Host-emerging pathogen interactions (3 ECTS)
- * Social sciences perspectives on One Health and Emerging Infectious Diseases (3 ECTS)
- * Maladies infectieuses émergentes et zoonoses (3 ECTS)

9 ECTS

+

- * Méthodes en épidémiologie : principes, méthodes et analyses de données (6 ECTS)
OU
- * From the field (3 ECTS) +
- * Epidemiology and biostatistics to critically receive scientific communications (3 ECTS)

6 ECTS

+

- Environments, Ecosystems and Biodiversity (3 ECTS)
OU

- * Genomics and evolutionary dynamics (3 ECTS)

3 ECTS

**UE optionnelles
12 ECTS**

- Emerging pathogens (3 ECTS)
- Aspects fondamentaux et économiques de la lutte contre les pathogènes (3 ECTS)
- From the Field (3 ECTS)
- Epidemiology and biostatistics to critically receive scientific communications (3 ECTS)
- Antiviral immunity (3 ECTS)
- Résistance aux antibiotiques (3 ECTS)
- Modern tool in vaccinology (3 ECTS)
- Monoclonal antibodies and therapeutic applications (3 ECTS)
- Mucosal immunity (3 ECTS)
- Initiation au logiciel R (3 ECTS)
- Introduction à l'épidémiologie ; construire et analyser une étude en épidémiologie, applications avec le logiciel R (6 ECTS)
- Outils et méthodes avancées en épidémiologie (3 ECTS)
- One health-One planet (3 ECTS)
- Environnement, Ecosystems and Biodiversity (3 ECTS)
- Genomics and evolutionary dynamics (3 ECTS)
- Analyse de risque en santé (3 ECTS)
- NGS Data in microbiology (3 ECTS)
- Population genetics (6 ECTS)
- Comparative phylogenetic approaches (6 ECTS)
- Biodiversité et écologie fonctionnelle des microorganismes (6 ECTS)
- Innovation (3 ECTS)
- Modeling of infectious diseases (3 ECTS)
- Création d'entreprise (6 ECTS)
- Création et gestion de bases de données (3 ECTS)
- Environnement et santé (3 ECTS)
- Changements climatiques et santé des populations (3 ECTS)

Common courses
18 ECTS

Host-emerging pathogens interactions

Persons in charge: India Leclercq

Credits: 3 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: from 5/10 to 9/10

Teaching modes: 24 h lecture course

Teaching language: English

Objectives: Assimilate the contents and integrate the knowledge on the interactions between pathogens and their hosts.

Topics: Animal reservoirs and vector competence, factors of emergence, molecular mechanisms of barrier-species crossing and adaptation to a new host.

Social sciences perspectives on One Health and Emerging Infectious Diseases, An interdisciplinary introduction

Persons in charge: Jules Villa

Credits: 3 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: from 11/01 to 15/01

Teaching modes: Lecture course

Teaching language: English

This intensive one-week course brings together an interdisciplinary cohort of social scientists to provide graduate students in One Health and Emerging Infectious Diseases with a concrete, hands-on introduction to how social sciences contribute to understanding and addressing contemporary health challenges.

This course presents how anthropologists, sociologists, historians, geographers, and other social scientists work alongside epidemiologists, clinicians, and public health professionals to address real-world problems. The course is offered in partnership with the UMR 7206 Éco-Anthropologie (MNHN) and features inter- and transdisciplinary examples of the integration of social science components in broader research projects concerned with health and emerging infectious diseases.

Objective: Gain a basic understanding of social science methods and epistemology, be able to read social science work and enter in meaningful dialogue with social scientists, be exposed to concrete examples of collaborations with social sciences on topics related to 1H-EID, apply social science insights to critically examine case studies in global health

Topics: social sciences, eco-anthropology, global health, interdisciplinary research projects.

Maladies infectieuses animales émergentes et zoonoses

Persons in charge: Nadia Haddad & Sophie Le Poder

Credits: 3 ECTS

Location: EnvA

Teaching period: from 28/09 to 02/10

Teaching modes: 22 h lecture course

Teaching language: English

Objectives: Educate students on animal and public health issues as part of the One Health, One Environment concept.

Topics: The circulation of pathogens in livestock, companion animals and wildlife will be presented with examples of the main infectious diseases (viral, bacterial, fungal and parasitic). Some of these diseases have a considerable economic and ecological impact. Others are due to zoonotic agents and have an impact on public health. This course emphasizes the importance of animal pathogens as models and/or agents of zoonosis.

Méthodes en épidémiologie : principes, méthodes et analyses de données (Nombre de places limité)

Persons in charge: Pierre-Yves Ancel / Pascal Astagneau

Credits: 6 ECTS

Location: UPCité

Teaching period: from 02/11 to 21/11 (To be confirmed)

Teaching modes: 40 h lecture course, 12 h tutorial work

Teaching language: French

Objectives: To acquire theoretical bases on the methodology and analysis in epidemiology and clinical epidemiology.

Topics: Descriptive epidemiology, observational analytic studies (case-control, cohorts), definition and consideration of biases, association measures, simple and multinomial logistic regression, methodology of randomized controlled trials.

From the field

Persons in charge: Solen Kernéis, Nathan Peiffer-Smadja and Loïc Epelboin

Credits: 3 ECTS

Location: UPCité

Teaching period: from 23/11 to 27/11

Teaching modes: 15 h lecture course, 10 h tutorial course

Teaching language: English

Objectives: Discover the “field” work, outside the research lab, of physicians, epidemiologists, clinical microbiologists and decision-makers involved in clinical management, prevention, investigation, clinical research on EIDs.

Topics: Clinical presentation of EIDs, evaluation of innovative prevention strategies (vaccines, non pharmaceutical interventions), protection of health-care workers, methods of outbreak investigation and control measures, clinical research in epidemic contexts, strategies of communication towards the public.

Epidemiology and biostatistics to critically receive scientific communications

Persons in charge: Loïc Desquilbet

Credits: 3 ECTS

Location: UPCité

Teaching period: from 16/11 to 20/11

Teaching modes: 15 h lecture course, 17 h practical work

Teaching language: English

Objectives: To acquire the basics of clinical epidemiology methodology and to critically evaluate scientific communications making causal inference.

Topics: Basics in biostatistics, statistical power, association biases, survival analyses, multivariate models, and study design for causal inference.

Environment, ecosystems and biodiversity

Persons in charge: Catherine Quiblier

Credits: 3 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: from 07/12 to 11/12

Teaching modes: 30 h lecture course

Teaching language: French

Objectives: Understand the diversity of mechanisms by which humans and their environment interact and the ecological and health consequences in the Anthropocene era.

Topics: Presentation of current environmental problems and the associated ecological, health and societal issues related to the disruption and degradation of ecosystems in the context of global and local changes. Through their expertise, the speakers will show how, in the era of the Anthropocene, the increase in human populations and activities modifies the interactions between the biotic and abiotic components of ecosystems, leading to damage to biodiversity and changes in the functioning of ecosystems, which in turn can impact certain ecosystem services provided to humans. Particular attention will be paid to the health consequences that may be involved.

Genomics and evolutionary dynamics

Persons in charge: Quentin Le Hingrat

Credits: 3 ECTS

Location: UPCité

Teaching period: from 26/10 to 29/10

Teaching modes: 17 h lecture course, 9 h tutorial work

Teaching language: English

Objectives: Learning the principles and drivers of evolutionary dynamics in microbes; understanding the experimental and analytical tools that can be harnessed to study microbial evolution and its impacts on public health.

Topics: Mechanisms and main drivers of evolutionary dynamics in microbes: introduction to the intra-host and intra-population evolutions of microbial populations; adaptative evolution of viruses to the human immune system and long-term viral evolution in immunocompromised patients; evolution of microbial genomes in the presence of antimicrobial drugs and vaccines; ecological dynamics of microbes: role of “One Health”, host availability, and host adaptation; interactions between co-circulating viral strains in the same host population; evolution of microbiomes in response to viral infection; experimental microbial evolution and its relevance to study the emergence of infectious diseases; modelling and predicting microbial evolution.

Tutorials during which students will present the applications of microbial evolution (“flipped classroom”).

Options

(12 ECTS)

All the modules described in the previous pages can also be selected

Emerging Pathogens

Persons in charge: Pierre-Emmanuel Ceccaldi

Credits: 3 ECTS

Location: Institut Pasteur and UPCité

Teaching period: from 19/10 to 23/10

Teaching modes: 28.5 h lecture course

Teaching language: English

Objectives: Understand the epidemiology, multiplication strategies, pathogenesis and emergence mechanisms of pathogens (viruses and bacteria) responsible for emerging infectious diseases.

Topics: Focus on different species of emerging viruses, such as Coronavirus, Filovirus, Hantavirus, Arbovirus, etc.

Aspects fondamentaux et économiques de la lutte contre les pathogènes

Persons in charge: Olivier Dussurget

Credits: 3 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: from 04/01 to 08/01

Teaching modes: 30 h lecture course

Teaching language: French

Objectives: Have an integrated view of infectious diseases by presenting their scientific, economic and sociological aspects.

Topics: Focus on strategies for the control of viral, bacterial, fungal and protozoa pathogens. Microbial diversity in infection control, modeling of infectious diseases, antibiotic and anti-retroviral resistance, vaccinology and vaccine epidemiology. Medico-economic aspects of infectious disease management, regulation of research involving humans.

Topics: Animal reservoirs and vector competence, factors of emergence, molecular mechanisms of barrier-species crossing and adaptation to a new host.

Antiviral immunity (Nombre de places limité)

Persons in charge: Sophie Siberil

Credits: 3 ECTS

Location: SU – Campus Pierre et Marie Curie

Teaching period: from 16/11 to 20/11

Teaching modes: 30 h lecture course

Teaching language: French and English

Objectives: Acquire a global vision of the current fundamental and clinical research in the field of antiviral immunity.

Topics: Innate immunity and viruses (NK cells, interferons), emerging viral diseases and vaccines, anti-viral immune memory, anti-CMs immunity, immunity and oncogenic viruses, acute infections and respiratory viruses immunity, anti-HIV immunity.

Monoclonal antibodies and therapeutic applications (Nombre de places limité)

Persons in charge: Sophie Siberil

Credits: 3 ECTS

Location: SU – Campus Pierre et Marie Curie

Teaching period: from 14/12 to 18/12

Teaching modes: 30 h lecture course

Teaching language: French and english

Objectives: The aim of this course is to present the different methods used to produce monoclonal antibodies directed against a particular target, to understand their different mechanisms of action and to gain a better understanding of their numerous applications and their use in research and human therapeutics.

Topics: Production and optimization of monoclonal antibodies by genetic and molecular engineering, examples of applications in research and diagnosis.

Nouvelles stratégies vaccinales (Nombre de places limité)

Persons in charge: Bertrand Bellier

Credits: 3 ECTS

Location: SU – Campus Pierre et Marie Curie

Teaching period: from 7/12 to 11/12

Teaching modes: 30 h lecture course

Teaching language: French

Objectives: Give a broad overview of the vaccine strategies developed today and how they meet the current challenges of vaccination. This course is organized around lectures by French or international, academic or industrial experts in the field of vaccination, whose expertise will cover the main areas of vaccine development and the main targets (HIV, HCV, tumors, etc.).

Topics: Vaccine antigens and their vectorization; genetic vaccines; new routes of vaccine administration; tolerogenic vaccines.

Mucosal immunity (Nombre de places limité)

Persons in charge:

Credits: 3 ECTS

Location: SU – Campus Pierre et Marie Curie
Teaching period: from 7/12 to 11/12
Teaching modes: 30 h lecture course
Teaching language: French

Objectives:

Topics:

Résistance aux antibiotiques

Persons in charge: Thierry Naas
Credits: 3 ECTS
Location: SU – Hôpital Bicêtre
Teaching period: from 30/11 to 4/12
Teaching modes: 25 h lecture course, 7 h tutorial work
Teaching language: French

Objectives: Deep knowledge and specialization in different aspects of microbiology in relation to health with lectures on the growing impact of resistance to antibacterials.

Topics: Mode of action of the main classes of antibiotics, their targets (transcription, translation, replication, wall...), the different mechanisms of resistance to antibiotics, the mobile genetic elements and the impact of antibiotics on the microbiota.

Initiation au logiciel R

Persons in charge: Vincent Guillemot & Yoann Madec
Credits: 3 ECTS
Location: Institut Pasteur
Teaching period: from 12/04 to 16/04
Teaching modes: 25 h lecture course
Teaching language: French

Objectives: Learn basics in database management and statistical analysis with the R software.

Topics: Present the R programming language by addressing, in particular, the importation, manipulation, export of data. Description of data using basic statistics, introduction to statistical tests and creation of graphs.

Introduction à l'épidémiologie ; construire et analyser une étude en épidémiologie, applications avec le logiciel R (Nombre de places limité)

Persons in charge: Julie Rivière
Credits: 6 ECTS
Location: EnvA

Teaching period: from 14/09 to 25/09 (To be confirmed)

Teaching modes: 30 h lecture course, 29 h tutorial work

Teaching language: French

Objectives: To acquire the basics of epidemiological studies, and to develop and analyze an epidemiological study using R software.

Topics: Descriptive and analytic epidemiology, design of epidemiological studies and methods of sampling, descriptive and analytical analyses (univariate and multivariate analyses, regressions), diagnostic tests, R software.

Outils et méthodes appliquées à l'épidémiologie (Nombre de places limité)

Persons in charge: Julie Rivière

Credits: 3 ECTS

Location: EnvA

Teaching period: from 12/10 to 16/10

Teaching modes: 15 h lecture course, 12 h tutorial work

Teaching language: French

Objectives: To apply tools and methods currently used in epidemiology to analyze an epidemiological study in depth (beyond the initial classical approaches in descriptive and analytical epidemiology, see the introductory UE to explore these topics).

Topics: Modeling, mixed models, survival analysis, bayesian and likelihood estimation, time series.

One Health – one Planet

Persons in charge: Eric Viollier

Credits: 3 ECTS

Teaching modes: 10h MOOC and personal work

Teaching language: English

Objectives: Learn from the Earth's past. To be open to different methodological approaches of geosciences and to the culture of geological and environmental risk. Learn how geosciences concepts and methods can help building a more comprehensive scheme of environmental factors potentially linked to (re)emerging infectious diseases.

Topics: Natural hazards, extreme events, climate change, coastal ocean and blue carbon concept, land/forest modification, agricultural practices air, soil, water pollution, standardization of life, from geological archives to 21st century scenarios, from local observations to global calculations. Tracking environmental modifications of a localized natural environment through an interdisciplinary approach (veterinary, geochemical, geophysical, microbiological, virological and hydrobiological approaches). Sampling and measurements strategies, practice of up-to-date field/lab equipment/instrumentation

Analyse de risque en santé (Nombre de places limité)

Persons in charge: Julie Rivière

Credits: 3 ECTS

Location: ENVA

Teaching period: From 26/10 to 30/10

Teaching modes: 30 h lecture course

Teaching language: French

Topics: Presentation of the approach and the main steps of the risk analysis (WHO approach); definition of the framework and objectives of a risk assessment; presentation of the qualitative and quantitative approaches and the limits of both approaches; understanding and criticizing a qualitative or quantitative risk assessment; conducting a qualitative risk analysis; discovering the quantitative approach, deterministic method; presentation of the link between risk assessment and risk management; risk management methods, principles, issues and limits; application to different fields: risk analysis in animal and human health, food hygiene; general principles of risk communication.

NGS data in microbiology

Persons in charge: Quentin Le Hingrat

Credits: 3 ECTS

Location: UPCité

Teaching period: From 18/01 to 22/01

Teaching modes:

Teaching language: English

Objectives: Consolidate the bases in the analysis of NGS data in microbiology. Learn how to analyze NGS data in microbiology and how to critically analyze these results.

Topics: The course will be divided into one-day sessions, each consisting of a brief introductory lesson followed by a practical session. Students will replicate analyses of NGS data using the readily available platform Galaxy. The topics covered during the week include: Microbiota analysis using 16S rRNA, shotgun metagenomics, transcriptomics. There will also be lessons on the applications of machine learning in microbiology.

Population genetics

Persons in charge: Pierre Gérard & Guillaume Achaz

Credits: 6 ECTS

Location: ENS

Teaching period: from 12/10 to 23/10

Teaching modes: 43 h lecture course, 3 h tutorial work, 8 h practical work

Teaching language: English

Objectives: Consolidate the theoretical bases in population genetics, and use them for the analysis of experimental data; acquire a critical view of the information that can be acquired from sequence data, at the individual, population or interspecies level, and understand the limits of using analysis tools and software.

Topics: Dynamics of genetic polymorphism at a locus: the neutral case; consequences of diploidy: effect of breeding regimes; multilocus genetic polymorphism and recombination; inferential statistics in population genetics; polymorphism in structured populations, speciation; dynamics of genetic polymorphism under selection; introduction to molecular evolution.

Comparative phylogenetics approaches (Pré-requis en maths nécessaires !)

Persons in charge: Guillaume Achaz & Paul Zaharias

Credits: 6 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: From 7/12 to 18/12

Teaching modes: 18 h lecture course, 9 h tutorial work, 27 h practical work

Teaching language: English

Objectives: Consolidate theoretical and practical bases in taxonomy, phylogeny, diversification and evolution of traits, whether genetic or genetic or morphological traits.

Topics: Database search and alignment, substitution models, phylogenetic inferences, evolution, diversification models, detection of selection via synonymous and non-synonymous mutations, species delineation, comparative genomics.

Biodiversité et écologie fonctionnelle des microorganismes

Persons in charge: Isabelle Florent & Julie Leloup

Credits: 6 ECTS

Location: SU/MNHN

Teaching period: From 7/09 to 18/09 – Exam week 51

Teaching modes: 48 h lecture course, 6 h tutorial work, 6 h practical work

Teaching language: French

Objectives: Have a global view of microorganisms from a taxonomic, structural and ecological point of view: archaea, bacteria, cyanobacteria and large eukaryotic phyla (e.g. protists, fungi).

Topics: Lessons will focus on the molecular and functional diversity of these microorganisms as well as their roles in the functioning of ecosystems and biogeochemical cycles at different scales.

Innovation

Persons in charge: Sébastien Pichon

Credits: 3 ECTS

Location: UPCité – Campus des Grands Moulins

Teaching period: From 4/01 to 08/01

Teaching modes: 12 h lecture course, 24 h tutorial work

Teaching language: English

Objectives: Acquire a knowledge base and a "toolbox" to structure your thinking and manage your innovation process. Understand the main players in the innovation ecosystem. Benefit of the best current practices. Take advantage of the examples studied to build your thinking through practical application.

Topics: Presentation of an innovation activity (organization and management) in the corporate environment. Case studies on the management of a pandemic crisis in a company or on the development of a company specialized in infectious diseases.

Modeling of infectious diseases

Persons in charge: Simon Cauchemez

Credits: 3 ECTS

Location: Institut Pasteur

Teaching period: from 19/04 to 23/04

Teaching modes: 15 h lecture course, 12 h tutorial work

Teaching language: English

Objectives: The objectives are that participants: 1) Understand the key theoretical concepts and techniques of infectious disease modeling; 2) Can read modeling papers, understand the strengths and limits of modeling approaches; and are able to use modeling results in their own research and effectively interact with modelers.

Topics: The course will be partitioned in three types of sessions: a set of lectures introducing key theoretical concepts and techniques, a seminar series illustrating how these concepts are being used to tackle major Public Health challenges, and practical sessions during which participants will learn to implement, run and use models.

Création et gestion de bases de données

Persons in charge: Stéphane Béchet

Credits: 3 ECTS

Location: Institut Pasteur

Teaching period: from 05/04 to 09/04

Teaching modes: 30 h lecture course

Teaching language: French

Objectives: Use of Access, Epidata and Wepi software to build and manage clinical and epidemiological databases.

Topics: Introduction to databases; Microsoft Access; RedCap; EpiData and Wepi.

Création d'entreprise

Persons in charge: Jonathan Weitzman, Madeleine Bouvier d'Yvoire

Credits: 6 ECTS

Location: UPCité - Campus des Grands Moulins

Teaching period: from 2/11 to 13/11

Teaching modes: 60 h tutorial work

Teaching language: French

Objectives: give the basics of business creation and encourage students to pursue the business opportunities that they may encounter during their studies and their careers.

Conferences and practical sessions.

Changements climatiques et santé des populations

Persons in charge: Tarik Benmarhnia and Kévin Jean

Credits: 3 ECTS

Location: Institut Pasteur

Teaching period: from 19/04 to 23/04

Teaching language: French

Objectives: understand the links between climate change and public health, and familiarize themselves with different tools for better characterizing these relationships.

Conferences and practical sessions.

Internships

To enhance acquisition of multidisciplinary knowledge, the practical phase of the Master program will rely on original and personalized internships. Practical internships will consist in a 5-6-month internship.

More innovative paths might be explored upon prior validation by the pedagogic committee, i.e. an interface research project between two laboratories, or collaboration between two students working together on cross-sectional issues around the same topic in two laboratories with complementary expertise.