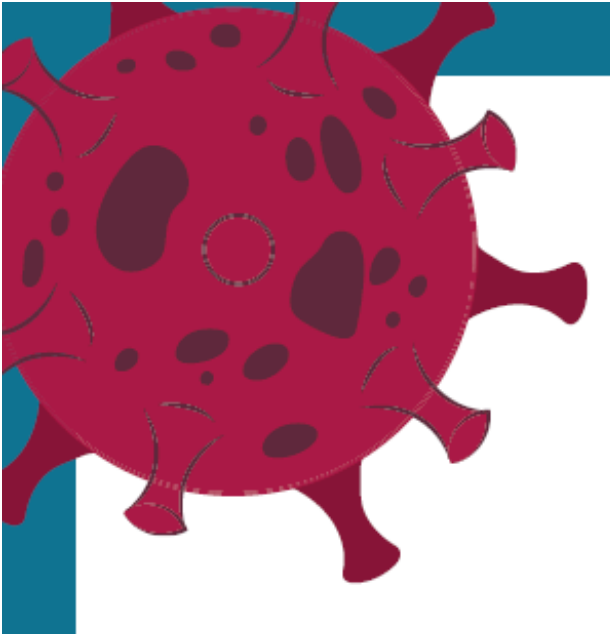


Master Molecular and Cellular Biology (BMC)

Emerging Infectious Diseases

Table des matières

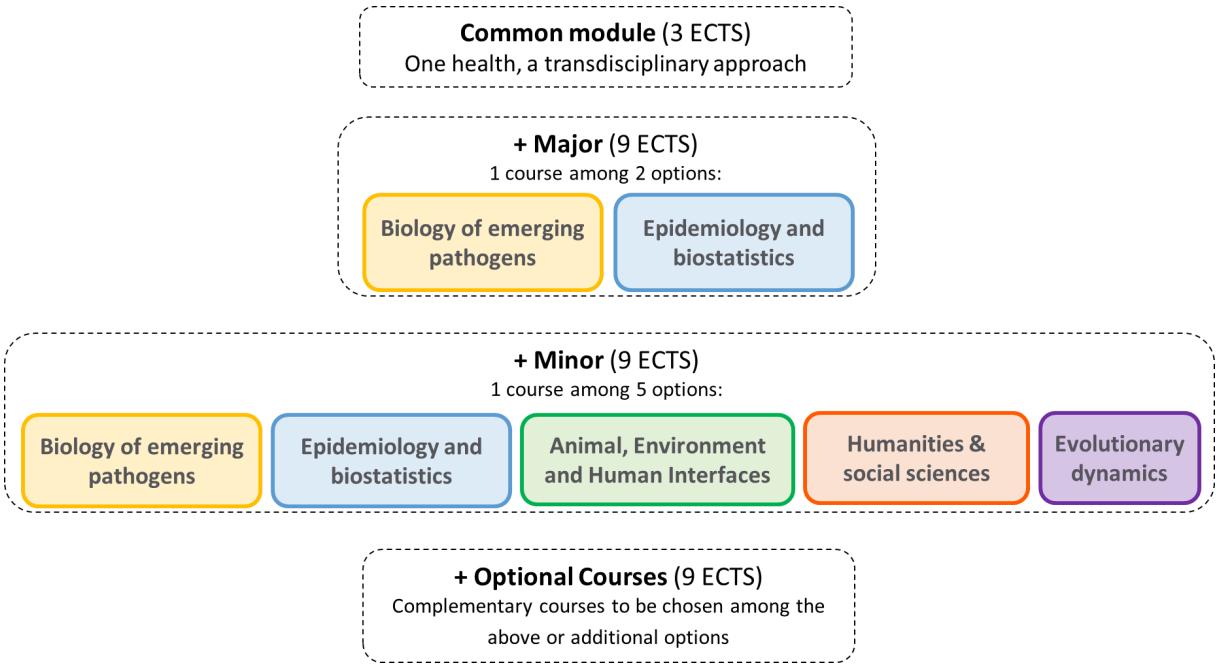
General presentation

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.

The students have a common module "One Health, an interdisciplinary approach" then one of the following majors can be chosen: biology of emerging pathogens or epidemiology and biostatistics. The course is completed either with the other major or with one of these three minors: Human-Animal-Environment Interfaces, Evolutionary Dynamics or Human and Social Sciences – and by 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 multidisciplinarity – 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.



Common course

One Health, a transdisciplinary approach

Persons in charge: Sandie Munier
Credits: 3 ECTS
Location: UPCité – Campus des Grands Moulins
Teaching period: week 39
Teaching modes: 15 h lecture course, 6 h tutorial work
Teaching language: English

Objectives: To have a global vision of the One Health approach and an integrated and multidisciplinary understanding of emerging infectious diseases.
Topics: Understand the One Health concept combining different approaches: epidemiology, pathogenesis and emergence mechanisms of pathogens (viruses and bacteria), the role of environmental degradation, the complex interactions between wild and domestic animals and humans and the societal consequences. Students with different backgrounds (physicians, scientists, veterinarians, engineers...) will do an interdisciplinary group work with an oral restitution on an emerging pathogen using the One Health approach.

Biology of emerging pathogens

Emerging Pathogens

Persons in charge: Pierre-Emmanuel Ceccaldi
Credits: 3 ECTS
Location: Institut Pasteur
Teaching period: week 42
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: week 2 (Exam the 13rd of February)
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.

Host-emerging pathogens interactions

Persons in charge: India Leclercq
Credits: 3 ECTS
Location: UPCité – Campus des Grands Moulins
Teaching period: week 43
Teaching modes: 24 h lecture course, 4 h tutorial work
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.

Antiviral immunity

Persons in charge: Sophie Siberil
Credits: 3 ECTS
Location: SU – Campus Pierre et Marie Curie
Teaching period: week 49
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.

Epidemiology and biostatistics

Three courses in option depending on the background of the student.

Course 1 - Basic

Epidemiology and biostatistics

Persons in charge: Loïc Desquilbet
Credits: 3 ECTS
Location: UPCité
Teaching period: week 47
Teaching modes: 25 h lecture course, 13 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.

From the field

Persons in charge: Solen Kernéis, Nathan Peiffer-Smadja and Loïc Epelboin
Credits: 3 ECTS
Location: UPCité
Teaching period: week 48
Teaching modes: 15 h lecture course, 10 h tutorial course
Teaching language: French

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.

Initiation au logiciel R

Persons in charge: Vincent Guillemot & Yoann Madec
Credits: 3 ECTS
Location: Institut Pasteur

Epidemiology and biostatistics

Teaching period: week 15
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.

Course 2 – Advanced

Méthodes en épidémiologie : principes, méthodes et analyses de données

Persons in charge: Pierre-Yves Ancel / Pascal Astagneau
Credits: 6 ECTS
Location: UPCité/SU
Teaching period: weeks 45 + 46 + 47
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.

Introduction à R et rappels statistiques

Persons in charge: Nathanaël Lapidus
Credits: 3 ECTS
Location: UPCité
Teaching period: weeks 45 + 46 + 47
Teaching modes: 21 h practical work
Teaching language: French

Objectives: To understand syntax of the R language, know the main statistical tools, data manipulation and graphical representation, to know how to explore documentation and online help.
Topics: Presentation of R and R Studio, introduction to programming in R, descriptive statistics, manipulation of tables, data management, main comparison tests, correlation, uni-

and multi-variate linear and logistic regression, graphical tools, best practices for reproducible research.

Course 3 – Advanced

Initiation à la conception et à l'analyse d'études en épidémiologie avec R

Persons in charge: Julie Rivière
Credits: 6 ECTS
Location: EnvA
Teaching period: weeks 37 + 38
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

Persons in charge: Julie Rivière
Credits: 3 ECTS
Location: EnvA
Teaching period: week 41
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 introductive UE to explore these topics).
Topics: Modeling, mixed models, survival analysis, bayesian and likelihood estimation, time series.

Animal, Environment and Human Interfaces

Environment, ecosystems and biodiversity

Persons in charge: Catherine Quiblier
Credits: 3 ECTS
Location: UPCité – Campus des Grands Moulins
Teaching period: week 50
Teaching modes: 30 h lecture course
Teaching language: English and 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.

One Health – one planet

Persons in charge: Eric Viollier
Credits: 3 ECTS
Location: IPGP/Field
Teaching period: week 51
Teaching modes: 8 h lecture course, 24 h field class / case study
Teaching language: French

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

Maladies infectieuses animales émergentes et zoonoses

Persons in charge: Nadia Haddad & Sophie Le Poder
Credits: 3 ECTS
Location: EnvA
Teaching period: week 40
Teaching modes: 22 h lecture course
Teaching language: French

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.

Formation en analyse du risque

Persons in charge: Julie Rivière
Credits: 3 ECTS
Location: ENVA
Teaching period: week 49
Teaching modes: 30 h lecture course
Teaching language: French

Topics: Presentation of the approach and the main steps of the risk analysis (WHOA 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.

Risques microbiologiques naturels ou provoqués

Persons in charge: Elise Morice
Credits: 6 ECTS
Location: SU – Campus Pierre et Marie Curie
Teaching period: Not opened in 2023
Teaching modes: 30 h lecture course, 30 h tutorial work

Animal, environment and human interfaces

Teaching language: French

Objectives: Controlling microbiological risk requires knowledge of the pathogenicity of the main agents responsible for disease, of the routes of transmission (epidemiological chains), of the means of analysis and research, and finally, of the authorities that manage, at the national and international levels, the issues related to infectious risk.
Topics: Natural microbiological risk: origin of the risk, transmission of pathogens, knowledge and control of the risk; concepts of epidemiology of infectious diseases; natural or induced microbiological risk (bioterrorism); surveillance, information and action agencies against transmissible diseases; treatment and prevention methods; microbiological containment levels; visual thinking, computer graphics, sketchnoting; communication tools.

Evolutionary dynamics

Genomics and evolutionary dynamics

Persons in charge: Quentin Le Hingrat
Credits: 3 ECTS
Location: UPCité
Teaching period: week 44
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").

Population genetics

Persons in charge: Pierre Gérard & Guillaume Achaz
Credits: 6 ECTS
Location: ENS
Teaching period: weeks 40 + 42
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

Persons in charge: Guillaume Achaz, Olivier Gascuel & Nicolas Puillandre
Credits: 6 ECTS
Location: UPCité – Campus des Grands Moulins
Teaching period: weeks 49 + 50
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
Teaching period: week 36 + 37
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.

Humanities and social sciences

Global health security, risks and memories

Persons in charge: Laëtitia Atlani-Duault
Credits: 3 ECTS
Location: UPCité
Teaching period: To be determined
Teaching modes: 24 h lecture course
Teaching language: English

Socio-anthropologie de la santé

Persons in charge: Véronique Duchesne
Credits: 3 ECTS
Location: UPCité - Campus des Saints Pères
Teaching period: Every monday 1:30-3:30 pm
Teaching modes: 24 h lecture course
Teaching language: French

Objectives: Knowledge of contemporary health issues in the global South, critical reading of scientific texts.
Topics: Medicine in development countries (mental illnesses, infectious diseases, traditional medicine) and global health through cases studies.

Anthropologie politique du développement

Persons in charge: Olivier Leservoisier et Laëtitia Atlani-Duault
Credits: 3 ECTS
Location: UPCité - Campus Saint-Germain-des-Prés
Teaching period: Every tuesday 3:45-5:45
Teaching modes: 24 h lecture course
Teaching language: French

Objectives: Understand the political dimension of development and humanitarian assistance. **Topics:** Decentralization and democratization in Africa. Socio-political and financial issues of the current reforms. Major issues, controversies and limits of humanitarian assistance.

Sociologie de la santé : santé, maladies et sociétés

Humanities and social sciences

Persons in charge: Laurence Simmat Durand
Credits: 3 ECTS
Location: UPCité - Campus Saint-Germain-des-Prés
Teaching period: Thursday morning, period to be determined
Teaching modes: 36 h lecture course
Teaching language: French

Objectives: First approach of the social processes that produce and frame the modes of management of health and illness in our contemporary societies.
Topics: Infectious diseases, description and influence of health and social protection systems in different national contexts. Sociological approach of health and illness experiences.

Ecological challenges from a multidisciplinary perspective

Persons in charge: Luc Abbadie et Nathalie Blanc
Credits: 3 ECTS
Location: SU
Teaching period: Monday 18th of September from 2:00 pm to 6:30 pm, then Friday from 4:30 to 6:30 (29th of September to mid-January)
Teaching modes: 36 h lecture course
Teaching language: English

Objectives: Understand the effects of human activities on the major balances of the biosphere, primarily climate change, the extinction of biodiversity, pollution, and the considerable pressure on natural resources and settlement dynamics.
Topics: Climate change, biodiversity, ecological limits & global health, energy transition, geopolitics and energy transition.

Options

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

Innovation

Persons in charge: Sébastien Pichon
Credits: 3 ECTS
Location: UPCité – Campus des Grands Moulins
Teaching period: week 3
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.

Qualité des milieux aquatiques et risques biologiques

Persons in charge: Fabien Joux & Julia Baudart
Credits: 3 ECTS
Location: SU
Teaching period: week 39
Teaching modes: 12 h lecture course, 24 h tutorial work
Teaching language: French

Objectives: Understand the dynamics of contamination sources of pollutants, their fate and their impacts on human health and aquatic ecosystems.
Topics: Analytical methods and field sampling, regulatory bacteriological analytical methods, evaluation of the ecological quality of an ecosystem, microbial toxicity tests applicable to aquatic environments. Eutrophication and toxic algal, organic pollutants and their degradation in aquatic environments.

Monoclonal antibodies and therapeutic applications

Persons in charge: Sophie Siberil
Credits: 3 ECTS
Location: SU – Campus Pierre et Marie Curie
Teaching period: Week 47

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

Persons in charge: Bertrand Bellier
Credits: 3 ECTS
Location: SU – Campus Pierre et Marie Curie
Teaching period: week 48
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.

Résistance aux antibiotiques

Persons in charge: Thierry Naas
Credits: 3 ECTS
Location: SU – Hôpital Bicêtre
Teaching period: week 47
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.

Modeling of infectious diseases

Persons in charge: Simon Cauchemez
Credits: 3 ECTS
Location: Institut Pasteur
Teaching period: week 20
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: week 16
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: To be determined
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.

Santé internationale, santé globale (Bases)

Persons in charge: André Garcia & Michelle Holdsworth
Credits: 3 ECTS
Location: UPCité/SU
Teaching period: week 49
Teaching modes: 21 h lecture course
Teaching language: French

Topics: Nutritional transition and chronic diseases related to alimentation, tropical endemics, Traveller's diseases, global emerging infectious diseases.

Surveillance épidémiologique et veille sanitaire (Bases)

Persons in charge: Pascal Astagneau
Credits: 3 ECTS
Location: SU/UPCité
Teaching period: week 48
Teaching modes: 18 h lecture course, 6 h tutorial work
Teaching language: French

Topics: Surveillance of infectious diseases and chronic diseases, environmental health surveillance, methods of investigation of an epidemic.

Santé internationale, santé globale (Approfondissement)

Persons in charge: André Garcia & Michelle Holdsworth
Credits: 3 ECTS
Location: UPCité/SU
Teaching period: week 2
Teaching modes: 21 h lecture course
Teaching language: French

Topics: Food systems and policies, maternal and child malnutrition, emerging pathologies in the South, control programs in the South.

Surveillance épidémiologique et veille sanitaire (Approfondissement)

Persons in charge: Pascal Astagneau
Credits: 3 ECTS
Location: UPCité/SU
Teaching period: week 3
Teaching modes: 18 h lecture course, 6 h tutorial work

Teaching language: French

Topics: Surveillance and modeling of emerging infectious diseases, Surveillance of seasonal influenza in France, Automated monitoring, Spatial analysis of surveillance data, Data analysis: application on R.

Stages

To enhance acquisition of multidisciplinary knowledge, the practical phase of the Master program will rely on original and personalized internships. Depending on the background of the student and his/her planning over the academic year, practical internships will consist in either a 6-month internship (in the major discipline) and a tutored project (minor discipline), or two 3-month internships.

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.