

Degree title: Biodiversity, Ecology, and Evolution

Program: ES, SEP

Specialization: none

Title of the module: ES1 - Diversity of Genomes across the Tree of Life

Start date: September M1S1

End date: December M1S1

Coordinator(s): Isabelle Florent (MNHN) & Nicolas Buisine (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S1	3	19.5	1.5	9	10	3	36

Objectives of the module:

The complete sequencing of genomes from an increasing number of organisms is profoundly changing our approach to many biological issues. This course will deal with the structural and functional diversity of the genomes - from prokaryotes to eukaryotes - as well as the methodologies that allowed access to this knowledge (sequences assembly, annotations, etc.) and those enabling them to be exploited (databases, comparative genomics, post-genomics, etc.).

Key words:

Chromosomal organizations, regulations, methylations, duplications, horizontal transfers, transferable elements, NGS, metagenomics, paleo-genomics.

Target skills:

Knowing: genomic structures, evolutionary forces on genomes, functional role of different genetic elements.
Understanding: Data from genomic analyses, comparative genomics, functional and scalable context.
Autonomous access: databases, navigation, bioinformatics analyses.

Pre-requisites:

Biology of organisms, cell biology, biochemistry, genetics, level L3.

Evaluation:

Written exam covering all courses and conferences (75%), TP reports (25%)

Date of the evaluation: December or January of M1S1

Evaluation procedure and scoring:

Session 1: x Written 75%, x Practical 25% , Continuous assessment , Oral
Session 2: Written , Practical , Continuous assessment , x Oral 100%

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES2 - Introduction to the biodiversity of microorganisms

Start date: September M1S1

End date: December M1S1

Coordinator(s): Delphine Depoix (MNHN) & Joëlle Dupont (MNHN)

Organization of the module :

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of weeks	Hours per week	Maximum participants
M1S1	3	17	4	8.5	9	3-4	20

Objectives of the module:

The purpose of this module is to present the taxonomy and biology of the main groups of microorganisms in relation to their ecosystem.

Key-words:

Prokaryotic and eukaryotic microorganisms, biodiversity, environment, ecosystems

Target skills:

Global vision of the diversity of the microbial world and identification and study techniques adapted to each group of microorganisms. Biology of organisms, cellular biology, taking into account the three domains of life.

Pre-requisites:

Notions in biochemistry, cell biology and molecular biology at L3 level.

Evaluation:

Written exam covering all courses and conferences (80%), TP reports (20%).

Date of the evaluation: December or January of M1S1

Evaluation procedure and scoring :

Session 1: Written 80%, Practical 20% , Continuous assessment , Oral

Session 2: Written , Practical , Continuous assessment, Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES3 – Physiological regulation mechanisms in the vertebrates

Start date: September M1S1

End date: December M1S1

Coordinator(s): Marie-Stéphanie Clerget-Froidevaux (MNHN) & Guillaume Pezeron (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S1	3	27	3	0	10	3	15

Objectives of the module:

The aim of this course is to present the mechanisms of physiological regulations in vertebrates, showing, by a comparative approach, their unity and diversity. Emphasis will be placed on the role of hormones in regulatory mechanisms in adults and in their establishment during embryonic and post-embryonic development.

This teaching is an indispensable prerequisite for understanding the disruptive action of the environment on the control of normal functions of organisms.

Key words:

Comparative Physiology, Endocrinology, Reproduction, Growth, Metabolism, Stress.

Target skills:

Mastering the bases of the normal functioning of organisms in order to study their disturbance by environmental factors.

Pre-requisites:

Bases in biochemistry, molecular and cellular biology and in animal physiology.

Evaluation:

Written exam covering all courses and conferences (60%), oral presentation of scientific article (40%)

Date of the evaluation: December and/or January of M1S1

Evaluation procedure and scoring:

Session 1: x Written 60%, Practical, Continuous assessment, x Oral 40%

Session 2: Written, Practical, Continuous assessment, x Oral 100%

Contact(s):

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Degree title : Biodiversity Ecology and Evolution

Program: ES, ECIRE, EEFEV

Specialization: none

Title of the module: ES4 – From genes to ecosystems

Start date: September M1S1

End date: December M1S1

Coordinator(s): Delphine Depoix (MNHN) & Manuela Lopez-Villavicencio (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of weeks	Hours per week	Maximum participants
M1S1	6	42	9	9	10	6	15

Objectives of the module:

Nothing makes sense in biology except in the light of evolution” (Dobzhansky, 1970).

The general objective of this course is to present the mechanisms that control the evolution of populations, especially facing the changes in their environment. Teaching focuses on the contributions of genetics and genomics to understanding the relationships between organisms and their physical and biological environment (species interactions). These themes, which are current subjects of studies in evolutionary ecology, will be illustrated by examples from the whole living world.

Key-words:

Population genetics, genetic diversity, evolutionary ecology, ecosystem functioning.

Target skills:

Understanding how ecosystems work in the light of evolutionary ecology.

Pre-requisites:

Bachelor (L3) in Biology of Organism, Population Biology, or Cellular and Molecular Biology.

Evaluation:

Session 1: written exam covering all the courses and conferences (4/7 of the final grade), oral presentation of a scientific paper (2/7 of the final grade), and practical course report (1/7 of final grade).

Session 2: written or oral exam, depending on the number of concerned students.

Date of the evaluation: December and/or January of M1S1

Evaluation procedure and scoring:

Session 1 : x Written 4/7 , x Practical 1/7 , Continuous assessment , x Oral 2/7

Session 2 : x Written , Practical , Continuous assessment , x Oral

Contact(s):

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Degree title : Biodiversity Ecology and Evolution

Program: ES

Specialization: none

Title of the Module: ES5 – Functional biology, interactions and adaptation of microorganisms

Start date: January M1S2

End date: April M1S2

Coordinator(s): Delphine Depoix (MNHN) & Sébastien Duperron (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of weeks	Hours per week	Maximum participants
M1S2	6	30.5	11	13	2	30	20

Objectives of the module:

This module follows ES2 and integrates diversity into the context of organisms functioning, their interactions, and adaptation to their environment. Topics covered include: functional biology of microorganisms, symbiosis, stress adaptation and relations between organisms and environment.

Key-words:

Prokaryotic and eukaryotic microorganisms, biodiversity, functional biology, symbiosis, environment, adaptation, stress.

Target skills:

Embrace the taxonomic and functional diversity of microorganisms in their proper environmental context. Understand symbiosis, adaptation and stress. Understanding, analyzing and communicating in the content of selected scientific papers.

Pre-requisites:

Notions of biochemistry, cell biology and molecular biology at Bachelor (L3) level. Bases in microbial diversity (ES2).

Evaluation:

Session 1. Written exam covering all the courses and conferences (70%), oral presentation of a scientific paper (20%), and practical course report (10%).

Session 2: written or oral exam, depending on the number of concerned students.

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1 : Written 80%, Practical 20% , Continuous assessment , Oral

Session 2 : Written , Practical , Continuous assessment , Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES6 - Defense and Communication Molecules from Microorganisms

Start date: January M1S2

End date: April M1S2

Coordinator(s): Séverine Zirah (MNHN) & Soizic Prado (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	18	4.5	7.5	1	26	15

Objectives of the module:

Understand the molecular mechanisms involved defense and communication of microorganisms. Explore the molecular diversity of bacterial and fungal specialized metabolites.

Key words:

Specialized (secondary) metabolites, antibiotics, antimicrobial peptides, toxins, virulence factors, quorum sensing.

Target skills:

Know the main families of microbial specialized metabolites and their mechanisms of action. Analyze and interpret article extracts. Make and interpret antimicrobial assays.

Pre-requisites:

Base knowledge of biochemistry.

Evaluation:

Session 1. Written exam covering all courses and conferences (80%) + practical course report (20%) common to ES5 and ES6. Session 2: written or oral exam, depending on the number of concerned students.

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: x Written (80%), x Practical (20%), Continuous Assessment, Oral

Session 2: x Written (80%), x Practical (20%, from session 1) Continuous Assessment, x Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES7 - Organism responses to environmental toxics and toxins

Start date: January M1S2

End date: April M1S2

Coordinator(s): Katia Comte (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants

Objectives of the module:

The main objectives of this course are to present the high diversity of "pollutants" in air and aquatic ecosystems, after defining and nuancing the different terms and origins (anthropogenic vs natural) of "contaminants", "xenobiotic", "toxic", and "toxins". The second objective is to introduce M1 students to ecotoxicology and toxinology through concrete examples provided in part by external stakeholders (ANSES, ADEME, INERIS, Universities). A progression in the course week, allows addressing the effects of these contaminants at different scales of observation (from the molecule, to cells, populations, ecosystem) on groups of organisms representative of food webs.

Key words:

Contaminants; Environmental pollution; Toxic effects; Risk assessment; Fate of pollutants in ecosystems; Toxinology.

Target skills:

Fundamentals of ecotoxicology. Multidisciplinary approach to the knowledge and mode of action of contaminants (natural and anthropogenic) in aquatic and terrestrial environments; risk assessment and management of these pollutants.

Pre-requisites:

None

Evaluation:

Written exam (3h, analysis of articles + course questions).

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: x Written (100%), Practical, Continuous Assessment, Oral

Session 2: x Written (100%), Practical, Continuous Assessment, Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES8 - Pharmacology approach: from molecule to clinic

Start date: January M1S2

End date: April M1S2

Coordinator(s): Soizic Prado (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	17	9	0	1	26	16

Objectives of the module:

The aim of this course is to give students a rational approach that is now indispensable for the development of new medicines from natural molecules. Theoretically, this course aims to train students in methods for selecting therapeutic agents, the design and isolation of bioactive molecules and their analysis as well as the chemical or biological optimization to enable their preclinical and clinical development.

Key words:

Natural substances, ethnopharmacology, pharmacochemistry, secondary metabolites, pharmacology, drug, high-throughput screening.

Target skills:

- Knowledge of methods for selecting natural molecule sources,
- Initiation to purification techniques of natural molecules,
- Introduction to the various spectroscopic methods used in structural analysis;
- Introduction to pharmaco-chemistry and high-throughput screening.

Pre-requisites:

Bachelor.

Evaluation:

Written exam and presentation of an oral article.

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: x Written, Practical, Continuous Assessment, x Oral

Session 2: Written, Practical, Continuous Assessment, Oral

Contact(s):

Soizic Prado, 01 40 79 31 19, soizic.prado@mnhn.fr

Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES9 – Environmental impact on the vertebrate physiology

Start date: January M1S2

End date: April M1S2

Coordinator(s): Marie-Stéphanie Clerget-Froidevaux (MNHN) & Fabrice Girardot (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	24	6	0	1	30	15

Objectives of the module:

The aim of this teaching is to present how various environmental factors (physical or chemical) are likely to modulate or disrupt physiological regulations by their interaction with certain hormones, their receptors or the signaling pathways they control.

This course is the logical continuation of module ES3.

Key words:

Receptors, signaling pathways, transduction, hormonal signal, endocrine disrupters, stress, reproduction, growth, metabolism.

Target skills:

Understand the organism's adaptation pathways to its environment. Know the mechanisms of action of endocrine disruptors and the different levels of hormonal pathways on which they can act and induce changes in body homeostasis

Pre-requisites:

ES3.

Evaluation:

Session 1. Written exam covering all courses and conferences (60%) + oral presentation if a scientific article (40%). Session 2: written or oral exam, depending on the number of concerned students.

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: x Written 60%), Practical, Continuous Assessment, x Oral (40%)

Session 2: x Written, Practical, Continuous Assessment, x Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES, SEP

Specialization: none

Title of the module: ES10 - Biodiversity in marine coastal environment: from the gene to the organism. (ES10/SEP53/4UG59)

Start date: January M1S2

End date: April M1S2

Coordinator(s): Isabelle Domart-Coulon & Cédric Hubas (MNHN), Stéphanie Auzoux-Bordenave (SU)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	6	2	22	1	30	16

Objectives of the module:

Practical course organized at the Concarneau Marine Station (MNHN), based on in situ sampling of coastal marine organisms, to illustrate methods currently used in marine biology for characterizing biodiversity at the gene, cell and organism levels. Combination of field trips, experiments in aquariology station and laboratory manipulations will allow discovering the commonly used approaches for analyzing biodiversity and adaptations of marine organisms in their environment.

In a context of global change, lessons will also focus on responses of organisms to natural and/or anthropogenic changes. Practical demonstrations will be based on the station's technical platforms (aquariology, HPLC, Molecular Biology, Scanning Electron Microscope, Epifluorescence Microscopy).

Key words:

Biodiversity, foreshore, interactions, microorganisms, adaptations, environmental parameters, global change.

Target skills:

To understand the diversity of benthic organisms and abiotic parameters in a changing environment: the tidal swing zone; to study some physiological adaptations through the measurement of biotic and abiotic parameters; to observe the diversity of free (microphytobenthos) or host-associated microbial assemblies, using coastal organism experiments.

Pre-requisites:

None.

Evaluation:

One written QCM (/20) and two written reports of experimental sessions (/40).

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: Written, Practical, Continuous Assessment, Oral

Session 2: Written, Practical, Continuous Assessment, Oral

Contact(s):

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Stéphanie Auzoux-Bordenave : stephanie.auzoux-bordenav@mnhn.fr

Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES11 - Animal models for the detection of toxins/toxics and disruptors

Start date: January M1S2

End date: April M1S2

Coordinator(s): Marie-Stéphanie Clerget-Froidevaux (MNHN) & Guillaume Pezeron (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	12	3	20	1	35	10

Objectives of the module:

The aim of this course is to allow students to become familiar with the various experimental approaches in ecotoxicology (biological tests, analytical tools), carried out under laboratory conditions on three animal models (fish, amphibians and mammals). This course will address, with concrete examples, the needs and potential of valorization offered through the use of molecular approaches (germ and somatic transgenesis). Imaging tools will be addressed through the use of imaging software applied to the impact analysis of endocrine disruptors, chemical waste, pollutants and toxins on these animal models.

Key words:

Detection, ecotoxicology, animal models, somatic and germ transgenesis, endocrine disruptors, toxins-toxic, transcription regulation.

Target skills:

Knowledge and use of *in vivo* detection tools for toxins, toxics and endocrine disruptors using animal models; knowledge of imaging tools.

Pre-requisites:

ES3.

Evaluation:

Written exam covering all courses and conferences (100%)

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: x Written (100%), Practical, Continuous Assessment, Oral

Session 2: Written, Practical, Continuous Assessment, Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES12 – Biology in silico

Start date: January M1S2

End date: April M1S2

Coordinator(s): Loic Ponger (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	3	0	30	0	1	30	12

Objectives of the module:

The aim of this practical course is to introduce students to bioinformatics. The module presents the algorithmics and use of the main tools associated with the analysis of nucleic and protein sequences. The module should allow students to be autonomous in conducting simple analyses, from searching for sequences in databases to building phylogenetic trees.

Key words:

Bioinformatics, nucleic or protein sequence analysis, alignment, phylogeny, research for motifs and molecular signatures..

Target skills:

Mastering concepts and methods related to the *in silico* analysis of nucleic and protein sequences.

Pre-requisites:

Know the basics of molecular biology (genes, proteins, promoters, ...) and the use of a computer.

Evaluation:

Written report based on a real case study (100%).

Date of the evaluation: March April M1S2

Evaluation procedure and scoring:

Session 1: Written, Practical, Continuous Assessment, Oral

Session 2: Written, Practical, Continuous Assessment, Oral

Contact(s):

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Degree title: Biodiversity, Ecology, and Evolution

Program: ES

Specialization: none

Title of the module: ES15 - Laboratory internship

Start date: April M1S2 End date: June M1S2

Coordinator(s): Linda Duval (MNHN) & Séverine Zirah (MNHN)

Organization of the module:

Semester	ECTS	CM (h)	TD (h)	TP (h)	Number of Weeks	Hours per week	Maximum participants
M1S2	9	0	0	0	7-8	35	18

Objectives of the module:

Conduct a practical internship in a research or R&D laboratory of public scientific and technological establishments (e.g. CNRS, INRA, IRSTEA, MNHN, Universities), public administrative establishments (e.g. ANSES, ONEMA) or companies (e.g. Véolia, EDF) in order to – understand the structuring of a research project within a team and its own contribution to this project, conceptually and experimentally.

Key words:

Practical internship in laboratory or an environmental agency.

Target skills:

Integration into a scientific workplace, writing of a scientific report and presenting a scientific seminar. Practical placement in a research or R&D laboratory of public scientific and technological establishments (e.g. CNRS, INRA, IRSTEA, Universities), public administrative establishments (e.g. ANSES, ONEMA) or companies (e.g. Véolia, EDF).

Pre-requisites:

Students already trained in biology/biochemistry/molecular biology with an interest in the environment, ecotoxicology, microbiology.

Evaluation:

Internship report evaluated by 2 reviewers (50%) and oral defense in front of the entire jury and other students (50%).

Date of the evaluation: June M2S2

Evaluation procedure and scoring:

Session 1: x Written, Practical, Continuous Assessment, x Oral

Session 2: Written, Practical, Continuous Assessment, Oral

Contact(s):

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