Master Integrative Biology of Plant-Microorganism-Environment Interactions (B2IPME), 2nd year

Teaching units 2017-2021

<table>
<tr><td>Module 1</td><td colspan="2">Biotic interactions : signal exchange</td><td>ECTS : 5</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td>Hours (lecture – tutorial – practical):</td><td>30 – 6 – 14</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>Program and content:</td><td colspan="4">To improve students' knowledge of plant-microorganism interactions (mutualist as well as parasitic), the mechanisms involved in these interactions are discussed.

General topics are:

-mechanisms of signal exchange in mutualistic and parasitic plant-microorganism interactions

-models and concepts of plant immunity in the framework of agroecology

Specific topics addressed:

Elements of plant immunity

- PAMP receptors
- Signaling in the nucleus
- Plasma membrane and early signal exchange
- Management of plant-microbe interactions

Plant-microbe-interactions and signaling in abiotic and biotic stress
- Cross-regulation of abiotic and biotic stresses
- Iron homeostasis and defense
- Metabolism and signal exchange of sulfur transport
- Signal exchange during seed development

Signaling between and within cells
- Auxines and cell signal exchange
- Hormones and redox status

Plant neuro-signalling
- Definition of concepts of plant neurobiology
- Concept of the « plant synapse »
- Similarity of amino acid transport in plants and neuronal transport of amino acids in animals</td></tr>
<tr><td>Acquired skills:</td><td colspan="4">This module represents a research area of prime importance in the research groups attached to the Master program. Its objective is to provide students with the knowledge necessary to understand in-depth the importance of cell signaling in the context of the adaption of plants to biotic and abiotic factors. The students should also become aware of the importance of this fundamental knowledge for applied research.</td></tr>
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<tr><td>Module 2</td><td colspan="2">Biotic interactions : agroecology and ecological engineering</td><td>ECTS : 6</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Hours (lecture – tutorial – practical):</td><td>25-25-0</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Content:</td><td colspan="3">- Agroecosystems: functioning, management and evaluation

- Interactions among organisms:
• plant/plant
• plant/microorganism
• microorganism/microorganism

- Ecosystem services provided by these organisms

- Integrated management of agroecosystems at different scales:
• reduction of inputs
• biocontrol of pests
• management of plant biodiversity
• management of sanitary risks
• management of agrosystems at the landscape scale

- Ecological engineering

- From agronomy to agroecology</td></tr>
<tr><td colspan="2">Acquired skills:</td><td colspan="3">General knowledge about management of agroecosystems. Detailed knowledge of biotic interactions and regulations in agroecosystems. Knowledge of control elements used to modify and exploit biological regulations and interactions in ecological engineering and agroecology approaches.</td></tr>
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Module 3	Biotechnological use of plant and microbial resources for health and well-being	ECTS : 5	
		Hours (lecture – tutorial – practical):	22-22-6

Content:	**Plant and fungal molecules of interest** (types of molecules, extraction and production methods) for nutrition, human health, well-being (pharmaceutics, cosmetics). **Approaches for exploiting molecules of interest :** -genetic resources: ethnobotany, breeding and improvement of plants -exploitation of plant and fungal metabolism, secondary metabolites -biotechnology of the algae -cell culture, molecular farming -biofuels, degradation of organic matter and biogas production -synthetic biology, reverse genetics **Evaluation and management of risks** -using plants and microorganisms in polluted soils (phytomanagement etc.) -nutrition security, toxicology -security and evaluation of technical risks.
Acquired skills:	-a vision of the possibilities to produce molecules of interest in plants and fungi for health, well-being and energy production -implementing molecular strategies for allowing and improving molecule production -to know and evaluate associated risks -bioremediation strategies of polluted environments

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<tr><td>Module 4</td><td colspan="2">Data acquisition and analysis</td><td>ECTS : 5</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td>Hours (lecture – tutorial – practical):</td><td>22-4-4</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>Content:</td><td colspan="4">Analysis and modification of genes and genomes
- Creation of genetic resources
- Molecular engineering : plant and fungal transgenes, mutagenesis, genome editing, reverse genetics, tilling
- Metagenomics, epigenetics
- Molecular markers, genotyping, bioinformatics, phylogenetic analysis

Protein analysis
- Protein interactions
- Production/purification of recombinant proteins (heterologous expression in yeast)
- Membrane traffic analysis tools

Analytical techniques
- Imaging and advanced microscopy
- Cytometry
- Mass spectrometry and proteomics
- High-throughput phenotyping
- Electrophysiology

Experimental setup and data analysis
-Cell models
-Sampling in laboratory and the field
-Data analysis</td></tr>
<tr><td>Acquired skills:</td><td colspan="4">In-depth knowledge of recent methods of analysis of genes, genomes, protein structure and protein dynamics. Up-to-date analysis techniques of plants and soil microorganisms. Planning of experiments and analyses in the plant/microbial domain.</td></tr>
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<tr><td>Module 5</td><td colspan="2">Project design and analysis / Professional education</td><td>ECTS : 10
Hours (lecture – tutorial – practical):</td><td>
12 – 38 – 0</td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Content:</td><td colspan="3">Project design and analysis:

-Bibliographical report

Students write a literature review of a topic within the Master's subject range, presenting the most relevant papers. Based on this analysis, perspectives for a fundamental or applied research project are developed.
The report is presented orally to the class and the teachers.

-Innovation project

Based on knowledge acquired throughout the first semester, students work in teams to develop a project of the creation of a company, which will be discussed considering its originality and feasibility.

Professional formation:

-Management practice

-Tools and knowledge necessary for professional integration in research and industry (interviews, CVs, professional network building). Participation in workshops on professional education offered by the university.

-English and scientific English

-Seminars by invited scientists from industry</td></tr>
<tr><td colspan="2">Acquired skills:</td><td colspan="3">Oral and written communication in the domain. Knowledge of subject-specific vocabulary. Bibliographic analysis and synthesis of a scientific topic. Project management. Management and communication skills. Teamworking.</td></tr>
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