

TEACHING PROGRAM

L : Lecture / Cours magistraux (CM)

T : Tutorials / Travaux dirigés (TD)

PL : Practical Lab work / Travaux pratiques (TP)

MASTER 1 - SEMESTER 1

U02-3161 TOXICOLOGY

L 15h T 10h

Teachers: Raphaël COATMEUR (AMU), Pierre-Henri VILLARD (AMU)

Lectures: Definitions: ecotoxicology and toxicology, toxicity and intoxication, xenobiotic, ecosystem, pollutant and contaminant. Sources of pollution. Classification of pollutants. Physicochemical properties of pollutants. The fate of pollutants in the environment and in organisms. Concept of residues. Toxicity of pollutants. Interactions between pollutants. Lethal and sub-lethal effects and their nature. Population distribution of the sensitivity of individuals to toxicants. Impacts of pollutants on the agro-ecosystem and the hydrosystem (ecotoxicological qualities of aquatic and terrestrial environments). Action of pollutants in organisms and concept of bio-indication. Population effects of pollutants. Target and non-target species (for pesticides). Risk assessment. Assessment of the biological quality of the media (IBGN).

Tutorials: Analysis of concrete cases and articles. Risk assessment of substances with or without a toxicity threshold, determination of hazards, analysis of dose-response relationships, analysis of exposure to chemical substances in different environments. Deterministic and probabilistic approaches.

U02-3163 INTEGRATED NUTRITION & METABOLISM OF PLANTS

L 15h T 6h PL 10h

Teachers: Raphaël LUGAN (AU), Laurent URBAN (AU)

Photosynthesis: Interception of light energy, photochemical reactions, photosynthetic carbon fixation (C3, C4, CAM), photorespiration, distribution of assimilates, regulation of photosynthetic activity. Water supply (absorption, transport), water state, concept of stress. Interactions between water nutrition and carbon nutrition. Mineral food.

Slides available online.

Practical work: Influence of ferti-irrigation management on the growth of vegetable crops and associated physiological parameters: influence of the water status (water and osmotic potentials, water content, transpiration, stomatal conductance) on photosynthesis, respiration and nitrogenous nutrition. The objective is also to master the use of tools such as the pressure chamber (Scholander type), LICOR, nitracheck...

The lab report is produced in the form of a scientific article.

Plant physiology lab work (10h)

The aim is to make students familiar with the main concepts and common techniques in plant physiology. We will examine how plants survive under environmental stress by modifying their physiology (water and mineral acquisition, photosynthesis...).

U02-3164 AGRONOMY, PLANT & ENVIRONMENT

L 18h T 12h

Teachers: Claude DOUSSAN (INRAE), Marta DEBOLINI (INRAE)

Objective of the module: to describe the soil and atmosphere compartments which allow exchanges between the plant and its environment. The module is separated into three parts: bioclimatology, soil physics, and biogeochemistry. The main physical, chemical and biological principles that govern the functioning of these compartments are presented and illustrated using contextualized examples. The modeling of certain processes is approached.

Prerequisites: function analysis, differential equations, notions of fluid dynamics, thermodynamics, conservation laws, solution chemistry, bases of organic chemistry

Course content

- Bioclimatology: Radiation, temperature, wind, water and water balance, carbon dioxide, energy balance. Impacts of climate change on agriculture. Spatial scales for taking climate into account

- Soil physics: Descriptive elements of the soil (volume, texture, structure), hydrostatic in soils (water properties, surface tension, capillarity, notion of water potential, retention curve), hydrodynamics (hydraulic conductivity, Darcy's law, Richards' equation), hydrology (calculation of stocks, infiltration, drainage, runoff, evapotranspiration). Associated instrumental techniques

- Biogeochemistry: the main types of soils and their formation, the organic constituents of soils, the main chemical reactions in soils, physical chemistry of liquid-solid interface, cycle of mineral elements. Establishment of root systems and their architecture, dynamics of mineral elements in solution, acquisition of mineral elements

4 hours of tutorials per subject are planned to apply the principles presented: simple numerical applications or modeling

Teaching aids: slides and courses in pdf format, paper supports, reference books.

Assessment: Personal work and exam at the end of the module (2h)

U02-3361 FUNDAMENTALS OF ECOLOGY, EVOLUTION & GENETICS

L 15h T 5h

Teachers: Morgane ROTH (INRAE), Benoît MOURY (INRAE), Cindy MORRIS (INRAE), Marc BARDIN (INRAE)

Objectifs d'apprentissage :

Ecology, evolution and genetics are disciplines that allow understanding major biological processes across different timescales. Mobilizing this knowledge is crucial when it comes to environmental or agricultural problematics. The objective of this course is to familiarize students with the nature and origin of biological diversity on Earth and, in particular, the processes of diversification on which plant breeding and emergence of plant diseases and pests are based. At the end of the class students will get familiar with the complexity of biological systems through the lens of the three disciplines and they should be able to identify in scientific literature/studies the biological forces shaping biodiversity at different scales (from micro-organisms to plants, from individuals to ecosystems). This course will provide the basic knowledge that will facilitate understanding of courses in the M2 program.

Description synthétique des enseignements :

The course is divided into 4 parts: 1) the timeline and evolutionary origins of life on Earth with a focus on terrestrial plants, microorganisms and insects, 2) the fundamental forces of evolution that lead to diversification and speciation, 3) the specific processes of speciation in plants and 4) the ecological traits of cropping systems that foster the co-existence of species and the dynamics of their populations.

- Travail attendu :

Part 1 and 2 will require the preparation of 10-minute oral presentations (one per semester)

- Modalités de contrôle des connaissances :

1 exam 1H30 coeff 1

- Prérequis :

Good level in English (reading, writing, speaking), sufficient background in biology (> highschool level)

- Compétences acquises :

Improved capacity to read scientific reading literature objectively, fundamental and integrative biology, capacity to participate in multidisciplinary activities

- Références bibliographiques et ressources numériques :

All the material will be provided in the class via the ENT

U02-3362 FUNDAMENTALS OF PLANT HEALTH

L 16h T 4h

Teachers: Marc BARDIN (INRAE), Cindy MORRIS (INRAE)

- **Objectifs d'apprentissage :**

At the end of the course students are expected to know examples of diseases of plants caused by bacteria, fungi, oomycetes, viruses and viroids as well as the major traits that distinguish these different types of organisms. They will learn where to find information about causes of disease, the important environmental factors that are favorable for disease and the available methods of control. They will also understand the importance of knowledge about the ecology of plant pathogens for developing methods of control that reduce the amounts of synthetic pesticides used in disease management.

- **Description synthétique des enseignements :**

The objective of this course is to provide students with an introduction to the basic concepts of Plant Pathology and plant health management. Students will learn 1) the definitions of plant disease/plant health and the principles of etiology, 2) concepts concerning disease epidemiology and 3) strategies of disease management. They will also become familiar with the full array of microorganisms that can cause harm to plants including bacteria, fungi, viruses and viroids. The course will include a series of lectures providing the basics of plant pathology and homework where the students will prepare and give a talk on the main phytosanitary problems encountered on cultivated plants.

- Travail attendu :

Attendance of class is mandatory. Students are expected to participate in discussions during class. Students will also prepare and deliver (to the class) a 20-minute presentation on the etiology, epidemiology and control methods of a phytosanitary problem of cultivated plants

- Modalités de contrôle des connaissances :

1 exam 1H30 coeff 1

- Prérequis :

Undergraduate level courses about the fundamentals of plant biology, microbiology and agronomy.

- Compétences acquises :

Good skills in oral and written English. Background in plant biology and microbiology equivalent to the first two years of undergraduate level training (2 years after highschool) ad minima.

- Références bibliographiques et ressources numériques :

All reference materials will be available on the EDT platform of Avignon University

U02-3363 CHEMISTRY OF NATURAL PRODUCTS

L 10h T 5h

Teacher: Gérald CULIOLI (AU)

- **Objectifs d'apprentissage :**

The aim of this course is to enable a student with a basic understanding of chemistry to be able to define, isolate and characterise a natural product. A brief description of some of the functions and applications of these molecules will also be given.

- **Description synthétique des enseignements :**

This course is divided in 4 parts. The main definitions useful in the field of natural products chemistry (e.g. primary/central vs secondary/specialized metabolites) will be developed in a brief introduction. The second part will be devoted to the description of the main classes of natural products on the basis of the biosynthetic pathways (acetate, shikimate, mevalonate?) which allow the production of such chemical compounds. The principal chromatographic (GC & HPLC) and analytical (1D & 2D NMR, MS?) techniques used for the purification and the structural characterization of natural products will be presented with specific applications in the field of phytochemistry. This course will end with a brief inventory of the different ecological roles played by natural substances in the environment and their use by mankind.

- **Travail attendu :**

Have a good knowledge of the course.

By means of the examples that will be provided, practice finding the biosynthetic origin and, in fact, the chemical class of a natural product via its chemical structure.

Be able to find extraction and separation strategies adapted to natural products.

Be able to characterize the chemical structure of a natural product using its spectral dataset (1D & 2D NMR, MS, IR...).

- **Modalités de contrôle des connaissances :**

2 exams with the same coefficient (0.5 each).

- **Prérequis :**

Basic knowledge of organic chemistry (main chemical functions, stereochemistry ...) is required

Good knowledge of chromatographic (HPLC, GC...) and spectroscopic (NMR, MS, IR, UV-Vis...) techniques is required.

Basic knowledge of biochemistry would be useful.

- **Compétences acquises :**

Define a natural product.

Know the main classes of natural products based on their biosynthetic origin.

Know the analytical tools for studying natural products, in particular be able to interpret spectral data resulting from the analysis of such molecules.

To know a wide range of functions and applications of these molecules.

- **Références bibliographiques et ressources numériques :**

U02-3364 PRINCIPLES OF TRANSFORMATION

L 10h T 5h

Teachers: Nicolas BORDENAVE (CANADA), Irène DE GUIDI (Supagro), Maryline VIAN (AU), Anne-Sylvie TIXIER, Sandrine PERINO

- **Objectifs d'apprentissage :**

To have the knowledge of food processing mainly unit operations

- **Description synthétique des enseignements :**

This course is divided in 3 parts. It will address three fundamental principles of food processing (unit operations, mass balance and energy balance). These theoretical principles will be put into practice through simple problems and linked to actual situations of large-scale food production. It will introduce the different strategies that can be used to stabilize foods, focusing on heat treatments such as pasteurization and sterilization. It addresses also the notion of equivalent treatment, process control, the various possible technologies and the

impact on food quality. Finally, an introduction to fermentation as an ancestral and cultural low-cost food preservation process, run by microbial enzymatic activities, that brings a certain stability and quality value to raw material such as veggies.

- Travail attendu :

A complete mastering about mass balance and energy balance.

- Modalités de contrôle des connaissances :

1 exam 1H, coeff 1

- Prérequis :

Bachelor degree in science

- Compétences acquises :

Principles of food processing (unit operations, mass balance and energy balance).

- Références bibliographiques et ressources numériques :

F. Chemat, E. Vorobiev (Editors)

Green Food Processing Techniques: Transformation, Preservation and Extraction.

Elsevier, Amsterdam, 588 pages. 2019. ISBN : 978-0-12-815353-6

S-U02-3365 FUNDAMENTALS OF FOOD SCIENCES

L 20h T 10h

Teachers: Nicolas BORDENAVE (INRAE), Maria-Cruz FIGUEROA (Supagro), Alexandre LECA (INRAE), Isabelle SOUCHON (INRAE)

This course will address the basic principles of food science, covering the four core disciplines of food science: food chemistry, food processing, food microbiology, and sensory science. Food chemistry will be addressed through basic biochemistry of the main classes of nutrients and their analysis (lipids, proteins, carbohydrates, water and minor food constituents), and applied to common food groups (cereals, dairy products, fruits and vegetables, etc.). Food processing and microbiology will be addressed through their fundamental principles and their applications to food preservation. Finally, sensory science will be addressed through its two main components, texture and flavor, and connections will be established with concepts of food biochemistry, showing how structure and physical/chemical properties of food constituents affect texture and flavor. The overall approach of this course will be integrative and will strive to make links between molecular properties of food constituents and properties of food itself.

U02-3162 MICROBIOLOGY

L 10h T 10h PL 10h

Teachers: Line CAPOWIEZ (INRAE), Alice CHATEAU-HUYOT (AU), Catherine DUPORT (AU), Fella HAMITOUCHE (INRAE)

- **Objectifs d'apprentissage :**

Identification and analysis of microbiomes that are indicators of agroecosystems and health.

- **Description synthétique des enseignements :**

This course covers the diversity of the microbial world, soil microbial ecosystems and bio-transformations, and the fate of pathogens in the environment. The labworks deal with enzymology and the microbiological study of a soil on the one hand, and the microbiological characterization of a food pathogen on the other.

- Travail attendu :

Synthesis, writing and restitution work. Practical work

- Modalités de contrôle des connaissances :

An oral presentation (40%), a written exam (40%), a practical work report (20%)

- Prérequis :

Pasteurian microbiology, molecular biology tools

- Compétences acquises :

Fundamental and methodological knowledge in the field of environmental microbiology

- Références bibliographiques et ressources numériques :

U02-3165 FUNDAMENTALS OF HUMAN NUTRITION

L 15h T 5h

Teachers: Florence COSTE (AU), Sophie ANTOINE (AU), Catherine RIVA (AU), Grégory MEYER (AU), Guillaume WALTHER (AU)

- Objectifs d'apprentissage :

- **Description synthétique des enseignements :**

The course will address the fundamental principles of human nutrition from basic energy metabolism to up-to-date nutritional recommendations. The metabolism of carbohydrates, proteins and lipids and its importance to human cellular homeostasis will be recalled. This will provide a basis for understanding how different foods (solids and liquids) affect human health, covering concepts of physiology from taste perception to the digestive process. This course will also address the most recent international recommendations for human nutrition (in healthy people or patients with chronic disease). In addition to nutritional aspects, the course will address the effect of fruits and legumes on cardiovascular health. The effect of different regimen on cardiovascular disease (prevalence, incidence) and mortality will be covered. The course will also address the effects of dietary fat, fibers, vitamins (E, A and C), phytosterols as well as main micronutrients (Carotenoids, Polyphenols) on preventable classic (dyslipidemia, hypertension, glycemic control, obesity) and novel (inflammation, oxidative stress) cardiovascular risk factors.

- Travail attendu :

Scientific paper reading and presentation

- Modalités de contrôle des connaissances :

1 Contrôle terminal de 3H coeff 1 : 1,5h Human Nutrition and 1,5h Cardiovascular Health

- Prérequis :

Basis in cardiovascular physiology

- Compétences acquises :

General knowledge on human nutrition and cardiovascular physiology and impact of plant food on cardiovascular health.

- Références bibliographiques et ressources numériques :

U02-3166 BASICS OF PROBABILITY & STATISTICS

L 15h T 6h PL 6h

Teachers: Florent BONNEU (AU), Céline LACAUX (AU)

This course introduces in a practical point of view the main mathematical concepts useful for statistical modeling. The first part is devoted to the definitions and rules of probability calculus, the presentation of the most useful random variables and their characteristics. The second part introduces the Central Limit Theorem, which plays an important role in the following parts on parameter estimation and hypothesis testing. The last part is dedicated to variance analysis, linear regression and an introduction toward the generalized linear models. Teaching focuses rigorously on mathematical application hypothesis and illustrates concepts on practical examples with the R software. The content of this course is fundamental for future courses on statistical modeling in numerous domains: environment, ecology, agronomy...

U02-3368 SCIENTIFIC METHODS

L 7h T 3h

Teachers: Cindy MORRIS (INRAE)

- Objectifs d'apprentissage :

Students are expected to improve their use of objective, analytical approaches in the definition of scientific questions and the formulation and testing of hypotheses. They will learn how to use laboratory notebooks and the importance of the notions of traceability and repeatability of their work. They are also expected to learn how to improve their ability to be concise, direct and pertinent when communicating their discoveries via written or oral formats.

- Description synthétique des enseignements :

The objective of this course is to stimulate students to think and debate about how scientific discoveries are made and communicated. The course will cover 6 topics: 1) History of the scientific method, 2) How culture influences science, 3) Methods to generate ideas and scientific goals, 4) Defining and testing hypotheses, 5) Why and how scientific results are communicated and 6) Ethical issues in science. The course is expected to influence the students' perspective on how they conduct their own research, especially in terms of defining objectives, testing hypotheses and assuring traceability.

- Travail attendu :

Attendance of class is mandatory. Students are expected to participate in discussions during class. They will read and analyze scientific articles in preparation for in-class discussions. Students will also prepare (with the course instructors) and deliver (to the class) a 5-minute presentation of research results for an audience of non-specialists.

- Modalités de contrôle des connaissances :

1 exam 1H00 coeff 1

- Prérequis :

Good skills in oral and written English. Background in biology equivalent to a highschool diploma ad minima.

- Compétences acquises :

Basic understanding of the processes by which scientific knowledge is created and communicated

- Références bibliographiques et ressources numériques :

All reference materials will be available on the EDT platform of Avignon University