Ph.D. IN AGRICULTURAL, FOOD AND ENVIRONMENTAL SCIENCES

XXXVIII EDITION

ACCADEMIC YEAR 2023/24

ORGANIZATION, ASSESSMENT AND DIDACTIC PLAN

List and course programs scheduled for the Academic Year 2023-2024

N.	Title	TEACHER	Hours
1	Progettare la Ricerca: i progetti europei – *Research Design: the European projects*	Prof. Nicola Paone	16
2	Economia e management del trasferimento tecnologico – *Economics and management of technology transfer*	Prof. Donato Iacobucci	16
3	From experimental design to the writing of a scientific paper and research evaluation / Dall'impostazione della prova sperimentale alla pubblicazione e valutazione della ricerca	Prof. Cianci Michele	12
4	The QPS (Qualified Presumption of Safety) approach: an overview	Prof. Lucia Aquilanti	12
5	La ristorazione collettiva e il rischio legato alla presenza di patogeni alimentari - Mass catering and risks related to the presence of food borne pathogens	Prof. Andrea Osimani	12
6	'Tecnologie molecolari innovative in ricerca e diagnostica: dai singoli geni all'intero genoma/ Innovative molecular technologies in research and diagnostics: from single genes to the whole genome'	Prof.ssa Lucia Landi	12
7	Radicali liberi ed antiossidanti / Free radicals and antioxidants	Prof.ssa Patricia Carloni	12
8	Produzione energetica dai residui del settore agro-alimentare e forestale Energy production from of the agri-food and forestry processing residues	Prof. Giuseppe Toscano	12
9	Valutazione di sostenibilità energetica e ambientale mediante Life Cycle Assessment	Prof. Daniele Duca	12
10	New Biotechnological Tools for the genetic improvement of fruit tree species	Dr. Silvia Sabbadini	12
11	Allevamento, benessere animale e qualità della carne Livestock, animal welfare and meat quality	Prof. Maria Federica Trombetta	12
12	Crop Genetic Resources, plant breeding, seed production and intellectual properties	Prof Roberto PAPA and Dr Serena Mariani (UniMC)	15
13	Crops and man: the history of crop domestication	Prof Laura NANNI	12
14	Machine Learning and Deep Learning: Methods and Applications in Bioinformatics	Dott. Maria Chiara Fiorentino	18
15	Plant genetic resources conservation, characterization and	Prof. Elena BITOCCHI	12

	use for sustainable agriculture		
16	Python for advanced data analysis	Dr Riccardo Rosati	16
17	Advanced methods of gene discovery	Dr Alice PIERI	6
18	The molecular bases of crop domestication	Dr Valerio Di Vittori	6
19	"Il fenomeno dell' antibiotico resistenza in ambito alimentare ed ambientale" - "*The antibiotic resistance issue in the food and environmental ecosystems*".	Prof. Cristiana Garofalo	12
20	Seedborne pathogens of agricultural crops: transmission, detection and management.	Dr. Marwa Moumni	12
21	La microbiologia degli alimenti fermentati tradizionali ed etnici - *The microbiology of traditional and ethnic fermented foods*	Dr. Federica Cardinali	12
22	Dietary micronutrients and polyphenols: their effects on cellular metabolism.	Dr Massimiliano Gasparrini	9
23	PLF and IoT, new strategies in reducing the environmental impact of livestock farming - Zootecnia di Precisione, nuove strategie per ridurre l'impatto ambientale degli allevamenti	Prof. Marina Pasquini	12
24	Contaminazione ed ecotossicologia nel suolo	Dott.ssa Arianna De Bernardi	12
25	Agricoltura di Precisione. Applicazioni nel campo della meccanizzazione Agricola	Prof. Ester Foppa Pedretti	12
26	Biologia di *Apis mellifera* e tutela della biodiversità - Honey bee biology and biodiversity protection	Prof.ssa Sara Ruschioni	12
27	Introduzione all'analisi multivariata dei dati e spettroscopia NIR / Introduction to multivariate data analysis and NIR spectroscopy	Dott.ssa Manuela Mancini	24
28	Coperture multifunzionali e risposta fisiologica dell'albero - Multifunctional covers and physiological response of the tree	Prof. Davide Neri	8
29	Ecofisiologia della radice nei sistemi arborei intensivi e disturbati - Root ecophysiology in intensive and disturbed tree systems	Prof. Davide Neri	9
30	Genetics, Biotechnology and Biosafety for plant genetic improvement	Prof. Bruno Mezzetti	12
31	Basics of the GEOBIA Approach in Remote-sensing Data Analysis on eCognition and Applications on forestry and agriculture	Dr. MD Abdul Mueed Choudhury	12
32	Physiologically-Based Models supporting the management of insects	Dott. Giorgio Sperandio	12
	Total Hours (equal to 65.83 CFU)		**395**

Courses offered by the University:
http://www.univpm.it/Entra/Engine/RAServePG.php/P/1088210010400/M/1085020010412/T/Corsi-Comuni-di-Ateneo

CONTATTI:

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Programmi dei Corsi

1

Titolo del Corso: **Progettare la ricerca: i progetti europei – Research Design: the European projects**

Docente: Prof. Nicola Paone

Ore complessive: 16

Programma

1. Introduzione agli strumenti e alle agenzie di finanziamento della ricerca.
2. La ricerca europea: programmi Quadro e Horizon 2020; gli strumenti di finanziamento alla ricerca.
3. Il ruolo dell'industria nei Programmi Quadro. Le piattaforme tecnologiche
4. I passi nella preparazione di un progetto: analisi della Call e del Workprogramme; definizione degli obiettivi; definizione del partenariato; definizione dell'impatto; il programma di lavoro; stato dell'arte; il budget e le risorse
5. La valutazione dei progetti
6. Le azioni per la Mobilità dei ricercatori (Marie Curie actions)
7. La conduzione, il progresso e la rendicontazione scientifica del progetto. (Meeting di progetto, deliverables, reports, ecc.)
8. La gestione amministrativa/finanziaria: la rendicontazione finanziaria; l'audit
9. Esempi di progetti
10. Tutorial sessions.

Modalità di iscrizione

L'iscrizione al Corso potrà essere effettuata attraverso la piattaforma Moodle, pertanto si invitano i dottorandi interessati ad effettuare la registrazione al seguente link:

- Piattaforma Moodle

Rilevazione presenze

Se possibile, per facilitare l'operazione di rilevazione delle presenze, si chiede cortesemente di scaricare sul proprio smartphone una applicazione per la lettura dei QR-code.

2

Titolo del Corso: **Economia e Management del Trasferimento Tecnologico**

Docente: Prof. Donato Iacobucci

Ore complessive: 16

Obiettivi formativi

Acquisire conoscenze sulle principali modalità di trasferimento tecnologico in ambito universitario. Acquisire strumenti di analisi e gestione dei processi di valorizzazione dei risultati della ricerca con specifico riferimento all'avvio di nuove imprese. Conoscere i servizi e le strutture di supporto ai processi di trasferimento tecnologico nell'Ateneo e in ambito regionale e nazionale.

Programma

La costituzione di spin-off accademici e di start-up: iter di costituzione, modalità di avvio e di gestione, fattori che ne favoriscono lo sviluppo.
I brevetti: condizioni di brevettabilità, iter di concessione dei brevetti in ambito nazionale e internazionale, valorizzazione sul mercato.
I contratti di collaborazione tra università e impresa: forme di relazione fra università e imprese nelle attività di ricerca condivisa e su commessa.

Metodologia didattica

Il corso è svolto attraverso lezioni frontali, seminari con esperti e lavori di gruppo.

Modalità di iscrizione
L'iscrizione al Corso potrà essere effettuata attraverso la piattaforma Moodle, pertanto si invitano i dottorandi interessati ad effettuare la registrazione al seguente link:

- Piattaforma Moodle

Rilevazione presenze
Se possibile, per facilitare l'operazione di rilevazione delle presenze, si chiede cortesemente di scaricare sul proprio smartphone una applicazione per la lettura dei QR-code.

3

In addition to the list of courses mentioned below, the seminars and conferences organized by the Department 3A can be taken in consideration as didactic activity recognized for the Ph.D. program.

Titolo del Corso: **From experimental design to the writing of a scientific paper and research evaluation / Dall'impostazione della prova sperimentale alla pubblicazione e valutazione della ricerca**

Docente: **Prof. Michele Cianci**

Ore complessive/Total number of hours: 12 = *2 CFU*
Lingua/Language*:* English

Programma/Program*:*

1. Importance of research quality for University;
2. Planning of a research activity: aims, literature search, experimental design, data elaboration;
3. The Scientific Method;
4. Structure and writing of a scientific paper;
5. Plagiarism; ChatGPT; Evaluation of quality of a paper, Individual and aggregate evaluation of research quality;
6. How to improve the presentation skills of PhD students.

The aim of the course is to give the students an overview of the scientific process from planning research to publishing and presenting research results. Room is given to open discussion of the topics presented.

Modalità di iscrizione/Course enrolment: per e-mail: m.cianci@univpm.it
Materiale didattico/Course material: disponibile sulla piattaforma LEARN
Modalità di erogazione/Course delivery: in presence and/or via TEAMS
Rilevazione presenze: con firma
Calendario/schedule:

- in aula **A** dalle 16,30 alle 18,30
- giugno 2024: martedì 25/ mercoledì 26/giovedì 27
- luglio 2024: martedì 2/ mercoledì 3/giovedì 4

4

Titolo del Corso: **The QPS (Qualified Presumption of Safety) approach: an overview**

Docente: Prof. **Lucia Aquilanti**

Ore complessive: 12 = 2 CFU

Themes:

- Introduction to EFSA (European Food Safety Authority)
- QPS approach: general definition
- Traditional use of micro-organisms
- Taxonomy-familiarities
- The role of molecular tools in QPS
- Advantages and disadvantages of the QPS when used for safety assessment
- QPS and GRAS (Generally Recognized As Safe) status: a comparative analysis

The program will be articulated in a series of seminars on the themes listed above, including applications and biosafety issues related to micro-organisms used in feed/food and feed/food productions, as well as genetically modified micro-organisms intended for use in feed/food and feed/food productions.

Date proposte:
Nella settimana 1-5 luglio 2024

In presenza presso studio docenti (area microbiologia)

5

Titolo del Corso: ***'La ristorazione collettiva e il rischio legato alla presenza di patogeni alimentari - Mass catering and risks related to the presence of food borne pathogens"***

Docente: **Prof. Andrea Osimani**

Ore complessive: 12 = 2 CFU

Obiettivo
Il corso illustrerà i principali Regolamenti Comunitari in materia di sicurezza alimentare focalizzando l'attenzione sulla ristorazione collettiva e sulle problematiche legate alla diffusione di zoonosi di origine alimentare con particolare riferimento ai principali patogeni alimentari (*Salmonella* spp. *Listeria monocytogenes* e *Campylobacter*). Verranno inoltre analizzati casi studio riportati nella letteratura scientifica.

The main European Regulation regarding food safety will be explained, with a focus on mass catering concerns towards the diffusion of food-borne zoonoses. In more detail, the risks concerning Salmonella spp., Listeria monocytogenes e Campylobacter will be analyzed. Moreover, case studies reported in the available scientific literature will be discussed.

Programma

- L'approccio alla sicurezza alimentare nell'Unione Europea
- La ristorazione collettiva
- Il rischio *Salmonella* spp. nella ristorazione collettiva
- Il rischio *Listeria monocytogenes* nella ristorazione collettiva
- Il rischio di specie termo tolleranti di *Campylobacter* nella ristorazione collettiva
- Casi studio

Program

- The food safety approach in the European Union
- Mass catering
- The risk of *Salmonella* spp. in mass catering
- The risk of *Listeria monocytogenes* in mass catering
- The risk of thermotolerant *Campylobacter* species in mass catering
- Case studies

Schedule: ***Aula D***
1 LUGLIO 2023, 11-13 - Lezione
8 LUGLIO 2023, 11-13 - Lezione
15 LUGLIO 2023, 11-13 – Lezione
22 LUGLIO 2023, 11-13 – Lezione
29 LUGLIO 2023, 9-13 – Esercitazioni

6

Titolo del Corso: **'*Tecnologie molecolari innovative in ricerca e diagnostica: dai singoli geni all'intero genoma/ Innovative molecular technologies in research and diagnostics: from single genes to the whole genome*'**

Docente: Prof.ssa **Lucia Landi**

Obiettivo del corso
Il corso, analizzando metodologie molecolari utili alla comprensione della struttura funzione ed espressione dei geni, ha l'obiettivo di mostrare come cambia l'approccio analitico e quali sono i risvolti applicativi se la prospettiva è spostata dai singoli geni all'intero genoma. Test pratici in laboratorio saranno allestiti inerenti allo studio di microrganismi.
Programma
Tecniche di analisi molecolari per lo studio di singoli geni:
- La PCR qualitativa end point, e quantitativa, Real Time (qPCR) e droplet digital PCR (ddPCR): differenze nell'approccio analitico e applicativo.
- Progettazione di esperimenti in qPCR e ddPCR

Approccio omico per lo studio strutturale, funzionale e comparativo dei genomi:
- Introduzione ai sistemi bioinformatici e computazionali per gli studi di genomica, trascrittomica, e del microbioma:
- Analisi strutturale dei genomi: tecniche di sequenziamento (Next Generation Sequencing: second-generation sequencing, third-generation sequencing)
- Analisi funzionale dei genomi: (annotazione dei genomi, e studio delle vie metaboliche: (es.Gene Ontology (GO); Kyoto Encyclopedia of Genes and Genomes (KEGG), metagenomica.
- Approcci per l'analisi comparativa tra genomi.

Test pratico in laboratorio: analisi ddPCR di singoli geni per lo studio di microrganismi associati alle piante.
Test pratico in laboratorio: panoramica dimostrativa su alcuni programmi utili per l'analisi di dati omici.

Organizzazione del corso
Tre lezioni in aula sui temi descritti (totale 8 ore)
Due esercitazioni pratiche in laboratorio (totale 4 ore)

Date proposte
10 Giugno 2024 dalle 11 alle 13 (2h)
12 Giugno 2024 dalle 14.30 alle 16.30 (2h)
14 Giugno 2024 dalle 14.30 alle 17.30 (3h)
17 Giugno 2024 dalle 14.30 alle 17.30 (3h)
19 Giugno 2024 dalle 14.30 alle 16.30 (2h)

Luogo del corso
10, 12, 17 Giugno in aula (da decidere)
14 Giugno Laboratorio di Patologia Vegetale (Edificio 1, Blocco D, piano PTTT)
19 Giugno Aula Informatica

Modalità del corso
In presenza e sulla piattaforma teams

Ore complessive: 12= 2 CFU

Course aim:
The course analyses the molecular techniques useful for understanding the structure, function, and expression of genes. The goal is showing how the analytical approach changes
and what are the application implications if the view is shifted from single genes to the whole genome. Laboratory experience will be set up concerning the study of microorganisms.

Themes and program:
Molecular techniques for single genes investigation:
- Qualitative end-point PCR, and quantitative, Real Time (qPCR) and droplet digital PCR (ddPCR): differences in the analytical and applicative approach.
- Experiments setup for qPCR and ddPCR technology.
Omics approach for the structural, functional, and comparative studies of genomes:
- Introduction to bioinformatics and computational tools for genomics, transcriptomics and microbiome investigations
- Structural genomics: sequencing techniques (Next Generation Sequencing: second-generation sequencing, third-generation sequencing)
- Functional genomics: (genome annotation, and metabolic pathways investigations: (e.g. Gene Ontology (GO); Kyoto Encyclopedia of Genes and Genomes (KEGG), metagenomica.
- Approaches for the comparative analysis of genomes.
Practical laboratory experience: ddPCR analysis of single genes for the study of plant-associated microorganisms.
Practical laboratory experience: demonstrative overview of some tools for the analysis of omics data.

Course schedule:
Three class on the themes listed above (8 hours complex).
Two laboratory practices, on the themes listed above (4 hours complex).

Schedule
10 June 2024 from 11am to 13am (2h)
12 June 2024 from 14.30pm to 16.30pm (2h)
14 June 2024 from 14.30pm to 17.30pm (3h)
17 June 2024 from 14.30pm to17.30pm (3h)
19 June 2024 from 14.30pm to 16.30pm (2h)

Rooms
10, 12, 17 June, in the classroom, (to decide)
14 June, Plant Pathology Laboratory, (Building 1, Block D, PTTT floor)
19 June, Computer classroom

Presence and teams platform -based modality

Total hours: 12= 2 CFU

7

Titolo del Corso: **Radicali liberi ed antiossidanti / Free radicals and antioxidants**

Docente: Prof.ssa **Patricia Carloni**

Ore complessive: 12= 2 CFU
Programma:
I radicali liberi (4 ore); Le principali classi di antiossidanti ed i loro meccanismi di azione (4 ore); Metodi per la determinazione dell'attività antiossidante negli alimenti (4 ore).
Calendario:
11 Aprile 2024, ore 9.30-13.30 (4h);
16 Aprile 2024, ore 9.30-13.30 (4h);
18 Aprile 2024, ore 9.30-13.30 (4h);
Modalità di svolgimento: Teams o **D3A c/o SIMAU Ingegneria Edificio 2 Belluschi Quota 165**

Credits (ECTS) 2, hours 12
Program:
Reactivity of radical species
Free Radicals (Property of radical species)
Radicals formations (Generality of radical reactions and initiation reactions)
Radicals reactivity (Propagation and Termination Reactions)
Persistent radicals (Persistent radicals and factors influencing their life time)
Antioxidants and the oxidation stress
ROS & RNS (Reactive Oxygen Species in details: production and reactivity)
Antioxidant Mechanisms (Mechanisms of action of antioxidant)
Food antioxidants (Main antioxidants in foods)
Review of methods to determine antioxidant activity in food
Antioxidant activity of Foods (Requirements for the use of methods to measure the antioxidant activity)
DIRECT Methods (Kinetic analysis of the lipid peroxidation process)
DIRECT COMPETITION Methods (Methods based on studying the kinetics of non-chain processes)

INDIRECT Methods (Study of the ability of antioxidant to react with a model species)
EPR Spectroscopy
EPR Tecnique and Spin Trapping (EPR Spectra Simulation and Examples)
Schedule:
April 11, 2024, 9.30-13.30 (4h);
April 16, 2024, 9.30-13.30 (4h);
April 18, 2024, 9.30-13.30 (4h);
Room: Teams or **D3A c/o SIMAU Ingegneria Edificio 2 Belluschi Quota 165**

8

Titolo del Corso: **Produzione energetica dai residui del settore agro-alimentare e forestale *Energy production from of the agri-food and forestry processing residues***

Docente: Prof. **Giuseppe Toscano**

Ore complessive: **12 = *2 CFU***

Programma
Inquadramento normativo e proprietà delle biomasse. Qualità dei biocombustibili solidi. Principali filiere e sistemi di produzione energetica. Analisi di un caso di studio.

Calendario
Gli incontri in presenza verranno svolti nel mese di giugno 2024.
Importante
si chiede cortesemente ai dottorandi che intendono partecipare al corso di comunicarlo mediante email a g.toscano@univpm.it **entro e non oltre il 4.05.24** al fine di pianificare eventuali attività di laboratorio.

9

Titolo del Corso: **Valutazione di sostenibilità energetica e ambientale mediante Life Cycle Assessment**
Docente: Prof. **Daniele Duca**

Ore complessive: 12 (2 CFU)

Programma:
Sostenibilità (definizioni, aspetti considerati, iniziative nazionali e internazionali). Utilizzo di risorse e impatto ambientale. Consumi energetici per settori produttivi. Analisi del ciclo di vita e relative norme ISO. Struttura dell'analisi, unità funzionali, confini di sistema, inventario, calcolo dell'impatto, problemi di allocazione. Indicatori usati per valutare l'impatto delle produzioni. Etichette ambientali. Analisi di articoli scientifici su casi di valutazioni LCA applicate in ambito agrario e agroalimentare.

Date:

- giovedì 20 giugno ore 10:00-13:00;
- venerdì 21 giugno ore 10:00-13:00;
- giovedì 27 giugno ore 10:00-13:00;
- venerdì 28 giugno ore 10:00-13:00.

Modalità di svolgimento: in presenza.

10

Titolo del Corso: **New Biotechnological Tools for the genetic improvement of fruit tree species**

Docente: **Dr. Silvia Sabbadini**

Total hours: 12 = 2 CFU

Course aim:
The main objective of the course is to provide theoretical and practical knowledge on the use of New biotechnological tools for plant genetic improvement, in particular applied to fruit tree species.

Themes and program:
- Main objective for the genetic improvement of fruit tree species (cultivars and rootstocks).
- Biotechnological methods for the genetic improvement of plants: Transgenesis, Cisgenesis, Trans-grafting, Gene editing, RNAi.
- Case studies of New Biotechnological Tools (NBTs) applied to fruit tree species.
- Examples of protocols applied for in vitro regeneration and genetic modification of fruit tree species.
- Laboratory experience: Agrobacterium tumefaciens-mediated transformation trial of grapevine somatic tissues and detection of transient transformation events.

Course schedule:
- 1 class on the themes listed above (4 hours).
- 2 laboratory practices, where an in vitro regeneration and transformation trial will be carried out by students on a specific fruit tree species (8 hours complex).

Schedule:
11,12 e 15 Marzo 2024 from 9.00 up to 13.00

Room:
General Arboriculture and arboreal cultivation area

11

Titolo del Corso:
Allevamento, benessere animale e qualità della carne
Livestock, animal welfare and meat quality

Docente: **Prof. Maria Federica Trombetta**

Credits (ECTS) 2, hours 12

Livestock, animal welfare and meat quality

The main breeding and feeding techniques for meat production will be illustrated, the community regulations on animal welfare, transport and slaughter will be considered, the parameters to evaluate the meat quality will be described.

1. Breeding and feeding techniques
2. Community regulation on animal welfare, transport and slaughter
3. Principal parameters for meat quality determination

4. Visit to farm/slaughterhouse

Date proposte
10 luglio 2024
17 luglio 2024
24 luglio 2024
31 luglio 2024

Le lezioni saranno svolte su piattaforma TEAMS.

12

Titolo del Corso: **Crop Genetic Resources, plant breeding, seed production and intellectual properties**
Docente: **Prof ROBERTO PAPA and Dr Serena Mariani (UniMC)**

***Credits* (ECTS) 2.5, hours 15**

Program
The course will illustrate the importance of the plant genetic resources and their utilization in the plant breeding and the different steps of a plant breeding programme, describing the different strategies with a brief analysis of different approaches, tools and outcomes (e.g. varieties). The second part will describe the main aspect of seed productions and the procedures of variety registration. The third part will offer an overview of the different systems of intellectual property over plants (PBR and Patents), and the legal framework at national, European and international level (e.g. UPOV, ITPGRFA), with a specific focus on emerging issues (e.g. open source solutions; essential derivation). The forth part will be devoted to a discussion and to a critical analysis on how the different systems interact and affect the innovation in agriculture and benefit farmers and citizen worldwide.

Objectives of the course
General knowledge of the key relations between IP systems and the seeds value chain and develop a critical knowledge in relation to the future of agriculture under a climate crisis.

Prerequisite: Agricultural Genetics and Plant breeding

Room: to be defined

Course schedule: approximately in June/July 2024

13

Titolo del Corso: **Crops and man: the history of crop domestication**

Docente: **Prof Laura NANNI**

***Credits* (ECTS) 2, hours 12**

Program
Agriculture is one of the greatest inventions of humanity. It has had marked biological, societal, and ecological consequences, which perdure to this day and will do so for many years to come.

The course will provide an overview on crop domestication and the consequences of domestication on the genetic diversity and on the genome. We will discuss some of the modern analytical tools that have allowed plant biologists and archaeologists to learn more about the evolution of crop, whose spread was human mediated.

Objectives of the course
- General knowledge on crop and human co-evolution

Prerequisite: Basic knowledge of Genetics, Plant biology and botany.

Room: to be defined or online

Course schedule: approximately in May/ June 2024.

Online Operating methods: Teams or Zoom

14

Titolo del Corso: **Machine Learning and Deep Learning: Methods and Applications in Bioinformatics**
Docente: Dott. Maria Chiara Fiorentino (Dipartimento di Ingegneria dell'Informazione, DII, UNIVPM)

Credits* *(ECTS) 3, hours 18

Program: Over the past years, machine-learning and feature-based tools were developed with the aim of learning bioinformatics characteristics. In general, the learning process of these algorithms can either be supervised or unsupervised, depending on the data being used to feed the algorithms. These technologies offer exciting new ways to tackle real-world challenges. However, after moving into the era of multimedia big data, machine-learning approaches have evolved into deep learning approaches, which are a more powerful and efficient way of dealing with the massive amounts of data generated from modern approaches and coping with the complexities of understanding real problems. Deep learning has taken key features of the machine learning model and has even taken it one step further by constantly teaching itself new abilities and adjusting existing ones. In this course, the foundations of Machine Learning and Deep Learning will be presented. How to extract and identify useful features that best represent your data, a few of the most important machine learning algorithms, and how to evaluate the performance of your machine learning algorithms will be the key core of the programme. Moreover, how to build neural networks and how to lead successful machine learning projects will be described. PhD students will work on case studies from bioinformatics. They will master not only the theory, but also see how it is applied. They will practice all these ideas in Python.

This course includes 18 hours of lessons (2 hours each session).

Lecture 1 – Introduction to Python
• Learn basics of programming with Python (Variables, Operators, Logic...)
• Develop Python Modules to Create Re-Usable Code
• Learn Object Oriented Python Programming Concepts
• Learn how to process images & videos using OpenCV
• Examples and exercises.

Lecture 2 - Introduction to Machine Learning
• Introduction in Machine Learning. Statistical Foundations.
• Supervised learning techniques for regression and classification

• Unsupervised learning techniques for data modeling and analysis
• Probabilistic versus non-probabilistic viewpoints
• Examples and exercises.

Lecture 3 – Data analysis with Machine Learning
• Learning parameters from data for various machine learning methods
• Optimization and inference algorithms for model learning
• Classify data using K-Means clustering, Support Vector Machines (SVM), KNN, Decision Trees, Naïve Bayes, and PCA
• Make predictions using linear regression, polynomial regression, and multivariate regression
• Data Visualization with MatPlotLib and Seaborn
• Use train/test and K-Fold cross validation to choose and tune your models
• Examples and exercises.

Lecture 4 - GWAS data analysis
• GWAS data analysis
• Testing various combinations of feature selection methods, data reduction techniques, training algorithms and classifier types using the data provided.
• Examples and exercises.

Lecture 5 – Introduction to Neural Networks
• The basics of neural networks including how to train them (e.g. back propagation).
• Examples and exercises.

Lecture 6 – Introduction to Deep Learning
• From features based to deep learning approaches
• Introduction to convolutional neural networks
• Introduction to Recurrent Neural Networks
• Examples and exercises.

Lecture 7 – Deep Learning Frameworks
• Use of popular Deep Learning libraries such as Keras, PyTorch, and Tensorflow applied to bioinformatics
problems.
• Training and applying convolutional and recurrent neural networks for image analysis.
• Utilizing data augmentation and other preprocessing steps to further improve the generalization.
• Examples and exercises.

Lecture 8 –Deep Learning for bioinformatics applications
• Application of Deep Learning to real-world scenarios such as object recognition and Computer Vision,
image and video processing, text analytics, Natural Language Processing, recommender systems, and other types of classifiers.
• Examples and exercises.

Lecture 9 – Generative Adversarial Networks
• Advanced topics: Generative Adversarial Networks, Deep Reinforcement Learning, Adversarial Attacks.
• Example and exercises.

Course schedule: approximatively June/ July 2024

Room: Teams or face to face lectures

15

Titolo del Corso: **Plant genetic resources conservation, characterization and use for sustainable agriculture**

Docente: **Prof. Elena BITOCCHI**

Credits* *(ECTS) 2, hours 12

Program
The course will be held in English. This course will provide students a large overview on plant genetic resources (PGR) use, management, conservation and exploitation, focusing on wild and domesticated forms, and on traditional landraces and modern varieties. The phenotypic and genotypic characterization of plant genetic resources is crucial to use the genetic diversity available for crop breeding. The course will propose different case studies related to the utilization of plant genetic resources in pre-breeding projects and programs.

Objectives of the course
- to acquire knowledge on plant genetic resources, how to characterize them and their use in breeding to improve varieties for agronomic and nutritional quality traits.

Prerequisite: Basic knowledge of genetics, biology and statistics.

Course schedule: approximately in November 2023, 4 different days, 3 hours each

04/12/2023 Aula M 10:00-13:00
07/12/2023 Aula G 14:00-17:00
11/12/2023 Aula F 10:00-13:00
18/12/2023 Aula F 10:00-13:00

16

Titolo del Corso: **Python for advanced data analysis***[v2]*
Docente: Riccardo Rosati (Dipartimento di Ingegneria dell'Informazione, DII, UNIVPM)

Credits* *(ECTS) 2.7, hours 16

Program:
Block #1 – Recall of programming foundations
Recall of python programming language (3h)
Data Structure (list, tuple, set, dictionary (1h)

Block #2 – Libraries for data representation
Numpy (1h)
Pandas (3h)

Block #3 – Data analysis (scikit-learn)
Pre-processing (1h)
Dimensionality Reduction (1h)
Brief introduction to clustering (1h)
Brief introduction to regression (2h)
Brief introduction to classification (3h)

Objectives of the course
General knowledge of the basic concepts of data manipulation / processing using Python
General knowledge of libraries / modules to apply machine learning techniques using Python

Prerequisite: basic elements of programming in Python; **for new users it is mandatory to previously follow, at least, one of these online courses:**
- *Fondamenti di Informatica (in Italian)* helded by Prof. Adriano Mancini (DII, Università Politecnica delle Marche; a.mancini@staff.univpm.it), https://univpm-my.sharepoint.com/:f:/g/personal/p004766_staff_univpm_it/Em57JXgNFAdKtJhiDWkqGJIBv4rw1UpHLyJJEf4z8WLhNw?e=odg0D9;
- *Introduction to Python (In English)*
https://www.datacamp.com/courses/intro-to-python-for-data-science

Course schedule: approximatively June/ July 2024

Room: Teams or face to face lectures

17

Titolo del Corso: **Advanced methods of gene discovery**
Docente: **Dr Alice PIERI**

***Credits* (ECTS) 1, hours 6**

Program
The course will be held in English. It will introduce the basis of bioinformatic analysis. Topics will cover sequencing techniques, gene annotation and transcriptomics. A focus will be given to Next Generation Sequencing (NGS) and gene expression analysis with case studies and practical classes on RNA-seq analysis workflow.

Objectives of the course
To acquire knowledge on how to deal with NGS data and get familiar with basic bioinformatic tools for RNA-seq analysis.

Prerequisite: Basic knowledge of molecular biology and genetics.

Room: Teams or face to face lectures.

Course schedule: approximately in May 2024, 3 different days, 2 hours each.

18

Titolo del Corso: **The molecular bases of crop domestication**
Docente: **Dr Valerio Di Vittori**

***Credits* (ECTS) 1, hours 6**

Program
The domestication is a quite recent, and still ongoing, process that leads constantly to significant changes in the morphology, physiology and molecular aspects of plants. Indeed, domesticated plants differ significantly from their wild progenitor for several traits, that together constitute the “domestication syndrome”.
These traits are often shared between different and phylogenetically distant species; starting from wild species sharing similar features (e.g., the ability to disperse seeds) domestication provided domesticated

crops that underwent similar modifications (e.g., the resistance to the loss of seeds) which fall under the definition of "parallel evolution". The course aims to provide knowledge on several aspects of the domestication, such as;

- Which are the main modifications at the molecular level that overall occurred during the domestication of several crops, and how these modifications reflected in changes on the plant physiology and phenotypes?;
- Did the molecular pathways/genes involved in the main phenotypic traits of the domestications conserve their function across different species?; and is the parallel phenotypic evolution that we observed in the domesticated species the result of a parallel evolution at the molecular level across different species (i.e., did the selection during domestication acted on the same loci/genes in different species to provide similar phenotypes)?

The course will provide an overview on the recent advances and gain in knowledge in the domestication topic, to provide a general picture on the domestication processes and on its effect on the genetic and phenotypic architecture of crop plants.

The course will be held in English.

Objectives of the course:

- To acquire general knowledge on the main effects and mechanisms at the basis of the crop domestication process, both at molecular and physiological levels;
- To acquire knowledge on the molecular and phenotypic bases of the most relevant traits of the "domestication syndrome" in model crops, and on the parallel evolution process that characterizes the domestication.

Prerequisite: Basic knowledge of genetics and plant biology.

Online Operating methods: Face to face and online (TEAMS).

Room: to be defined.

Course schedule: approximately in June 2024, 3 different days, 2 hours each.

19

Titolo del Corso: **"Il fenomeno dell'antibiotico resistenza in ambito alimentare ed ambientale" - "The antibiotic resistance issue in the food and environmental ecosystems".**

Docente: **Prof. Cristiana Garofalo**

Objectives of the course

The antibiotic resistance issue will be explained, with a focus on the main transmission routes of antibiotic-resistant bacteria and antibiotic resistance genes. In detail, the resistance to carbapenems, new generation antibiotics considered the latest therapeutic line against infections by Gram-bacteria will be treated. The main reservoirs of these resistances in the food and environmental ecosystems will be identified with a specific focus to the animal supply chain. Moreover, case studies reported in the available scientific literature will be discussed.

Ore complessive: 12 = 2 CFU

Program

- *What is the antibiotic resistance?*
- *Carbapenem resistant bacteria and carbapenem resistance genes*

- *The main reservoirs and mechanisms of diffusion of antibiotic resistance*
- *The spread of antibiotic-resistant bacteria and resistance genes in the animal supply chain*
- *Case studies*

Course schedule:
lunedì 24 giugno 2024 11.00-13.00
lunedì 1 luglio 2024 11.00-13.00
lunedì 8 luglio 2024 11.00-13.00
lunedì 15 luglio 2024 11.00-13.00
lunedì 22 luglio 2024 9.00-13.00

20

Titolo del Corso: **Seedborne pathogens of agricultural crops: transmission, detection and management.**
Docente: **Dr. Marwa Moumni**

Credits (ECTS) 2, hours 12

Program
This course will be held in English.

Seeds play a crucial role in promoting food security and healthy foods, and almost 90% of the world's food crops is grown from seeds. Seeds are an important nutrient to survive pathogens in nature. The pathogens associated with seeds are considered one of the major means to disseminate diseases from infected to non-infected areas around the world by international trade. Seedborne pathogens limit production in many crops and can cause serious economic losses for growers. Therefore, sowing healthy seeds with high quality is essential to secure crop yields and food production. The use of seed certified to be disease-free or certified to have disease levels below a threshold is often recommended as the primary management strategy. Seed health testing to detect seedborne pathogens is a fundamental step in the management of crop diseases. Another critical and important step for the production of high quality seeds is the seed treatment. Localization of pathogen in seed is a very important step for the success of seed treatments, to ensure seed quality and increased yields. Different kinds of treatments can be used, which will depend on where the pathogen is localized on or in the seed, and these can include seed disinfestation, disinfection and/or protection. Integrated pest management strategies can provide more environmentally sound and economically feasible alternatives for seedborne disease management. These strategies are needed to minimize the inoculum of potential pathogens on seeds, drawing on management components that are currently available to farmers, or can be made available in the near future.

This course will address both in theory and practice the classical and innovative tools for detecting fungal pathogens on seeds, with a special focus on biological control of seedborne pathogens.

The course will be divided between theory sessions and laboratory practice.

1. Seedborne diseases: contamination, transmission, and localization.
2. Conventional methods for seed health testing.
3. Innovative methods for seed health testing.
4. Seed treatment using fungicides and physical means.
5. Alternative methods to control seedborne pathogens.

6. Practical work in the laboratory. Performance of some experimental procedures for the conventional and molecular tools for detection and identification of main seedborne fungi.

Objectives of the course

- The main aim of this course:

(a) To acquire a general knowledge of the main seedborne pathogens (fungi, bacteria, and viruses) and seed transmission of fungal diseases.
(b) To learn the different methods used for seed health testing, and seed treatment of agriculture crop.
(c) To learn and practice some of the laboratory methods and protocols for the detection of seedborne fungi using conventional and molecular tools.

Prerequisite: Basic knowledge on plant pathology.

Room: to be defined

Course schedule: 12/03, 15/03, 19/03, 22/03, 26/03, and 02/04. 2h/day (12 h total), 14:30 - 16:30

21

Titolo del Corso: "***La microbiologia degli alimenti fermentati tradizionali ed etnici***" / "***The microbiology of traditional and ethnic fermented foods***"

Docente: **Dr. Federica Cardinali**

Ore complessive: 12 = 2 CFU

Objectives of the course

Il corso intende fornire approfondimenti sugli aspetti microbiologici di prodotti alimentari fermentati di rilevante importanza culturale, sociale ed economica sia nazionale che internazionale. Una parte del corso sarà altresì dedicata alla descrizione di alimenti fermentati non convenzionali e provenienti da altre culture, con particolare riferimento agli aspetti microbiologici. In particolare, verranno approfondite le dinamiche microbiche e il loro impatto tecnologico e sensoriale nei seguenti alimenti fermentati: aceto, kefir, olive, boza e cacao.

In this course, insights into the microbiological aspects of fermented food products of significant national and international cultural, social, and economic importance will be provided. A part of the course will deal with some non-conventional foods and beverages that are more commonly manufactured in other countries. In more detail, the microbial dynamics and their technological and sensorial impact in the following fermented foods will be discussed: vinegar, kefir, olives, boza and cocoa.

Program

I microrganismi chiave negli alimenti fermentati
La microbiologia dell'aceto e dell'aceto balsamico tradizionale
La microbiologia del kefir e il consorzio microbico dei grani di kefir
Le trasformazioni microbiche alla base della produzione di olive

Una antica bevanda fermentata a base di cereali: la boza
Dalla bacca di cacao al cioccolato: le trasformazioni microbiche

The key microorganisms in fermented foods
The microbiology of vinegar and traditional balsamic vinegar
The microbiology of kefir and the microbial consortium of kefir grains
Microbial transformations at the base of olive production
An ancient, fermented cereal-based drink: the boza
From cocoa berry to chocolate: microbial transformations

Schedule:
5 luglio 2024, 14.30-16.30 – lezione 2 ore (In presenza)
12 luglio 2024, 14.30-16.30 – lezione 2 ore (In presenza)
19 luglio 2024, 14.30-16.30 – lezione 2 ore (In presenza)
26 luglio 2024, 14.30-16.30 – lezione 2 ore (In presenza)
02 agosto 2024, 9.30-13.30 – esercitazioni 4 ore (In presenza)

22

Titolo del Corso: **Dietary micronutrients and polyphenols: their effects on cellular metabolism.**

Docente: **Dott. Massimiliano Gasparrini**

Credits*:* 1,5

Hours*:* 9 (lectures 4,5 hours; laboratory activities 4,5 hours)

SSD: BIO/10 (Biochemistry)

Development of the course The course will be organized in frontal lectures and practical activities in the laboratory.

Aims
Lifestyle and diet are crucial factors for promoting and maintaining good health during the entire life course and preventing several chronic diseases. In this sense micronutrients (vitamins) and polyphenols naturally present in fruit and vegetables, represent precious allies for maintaining a good state of health. For these reasons the course will focus on the beneficial role of specific dietary bioactive compounds, highlighting their effect in cellular metabolism (in particular in inflammatory conditions) and deeply investigating the signalling pathways and the molecular mechanisms involved. In addition to frontal lectures, the course will be characterized by laboratories activities and demonstrations that will allow students to practice with cell cultures work and with the common laboratory techniques and assays related to it.

Program
• Micronutrients and polyphenols vs inflammatory conditions: state of the art.
• How different bioactive compound exert their effects? Molecular mechanisms and involved pathways.
• Cell cultures work: methodology and techniques.
• Practical application and demonstration in lab.

Objectives of the course
- ✓ to know the main dietary bioactive compounds and the functional foods involved in anti-inflammatory response;
- ✓ to know how investigate and study the molecular mechanisms and the pathways involved in bioactive compound response;

- ✓ to know and apply cell cultures techniques and assays to evaluate cellular metabolism, focusing on inflammatory conditions.

All the lessons will be attended in presence.

Proposal schedule:
May 13-14 2024, (4 h): room to define_FRONTAL LECTURES
May 15-16 2024, (5 h): D3A- Biochemistry laboratories_PRATICAL ACTIVITIES

Providing a laboratory part, interested students are invited to communicate their presence at the lessons by May 3, 2024. (m.gasparrini@staff.univpm.it)

23

Titolo del Corso:
PLF and IoT, new strategies in reducing the environmental impact of livestock farming - *Zootecnia di Precisione, nuove strategie per ridurre l'impatto ambientale degli allevamenti*

Docente: **Prof. Marina Pasquini**

Total hours and Credits / Ore Totali e CFU:
12 hours = 2 ECTS / *12 ore = 2 CFU*

Objectives of the course / Obiettivi del corso*:*
The aim of the course is to provide knowledge about Precision Livestock Farming (PLF) and the main electronic tools for tracking and monitoring livestock to improve their sustainable production and reproduction, health, welfare, and reducing their impact on the environment.
L'obiettivo del corso è quello di fornire conoscenze sulla moderna Zootecnia di Precisione (PLF) e sui principali strumenti elettronici (sensori) per il tracciamento e il monitoraggio del bestiame per rendere più sostenibili la produzione e riproduzione, la salute ed il benessere del bestiame riducendo il loro impatto sull'ambiente.

Program - Main topics / Programma - Argomenti principali:

- Precision Livestock Farming (PLF)
  Zootecnia di Precisione
- Environmental effects of livestock farming on soil, water, air, crops and strategies to mitigate environmental risks
  Effetti degli allevamenti su suolo, acqua, aria, colture e strategie per mitigare i rischi ambientali
- Internet of Things (IoT), Data Storing, Big Data, Machine Learning
  Internet of Things (IoT), Data Storing, Big Data, Machine Learning
- Technical improvement: On-Animal and Off-Animal Sensors/Devices
  Nuovi sensori per la zootecnia: On-Animal and Off-Animal
- Precision Livestock Farming and feeding efficiency
  Zootecnia di Precisione ed efficienza alimentare
- Precision Livestock Farming and climate changes
  Zootecnia di Precisione e cambiamenti climatici
- Individual presentation of a case study by each PhD student
  Presentazione e discussione di un caso di studio da parte di ciascun Dottorando

Course Schedule / Calendario:
Dates will be announced later (indicative period of lectures: 1st June - 30th July 2024);
4 days (3 hours/day), including 1 day for PhD students case study reports.

Le date saranno comunicate in seguito (periodo indicativo delle lezioni: 1° giugno - 30 luglio 2024);
4 giorni, (3 ore/giorno), di cui 1 giorno dedicato ai casi di studio presentati e discussi dai dottorandi.

Course Registration / Iscrizione al Corso:

Doctoral Students who would like to attend the course, are kindly requested to communicate it via email to m.pasquini@staff.univpm.it no later than May 15, 2024.

Si chiede cortesemente ai dottorandi che intendono partecipare al corso di comunicarlo mediante email a m.pasquini@staff.univpm.it entro e non oltre il 15 maggio 2024.

Room / Aula:

To be defined.

Da definire.

Operating methods / Modalità di erogazione del corso:

The program will consist of frontal lectures; for the last lesson of the course, each PhD Student will summarize and critically analyze a case study taken from the available scientific literature.

At present, lessons are scheduled in presence, but the course could take place online by the TEAMS platform if necessary. Students will be informed with a message to their registered email address.

Il programma si articolerà in un ciclo di lezioni frontali; nell'ultima lezione del corso, ciascun dottorando riassumerà e analizzerà criticamente un caso studio tratto dalla letteratura scientifica disponibile.

Allo stato attuale, le lezioni sono programmate in presenza, ma -se necessario- il corso potrebbe svolgersi online, tramite la piattaforma TEAMS. Gli studenti saranno informati tramite messaggio mail che riceveranno al loro indirizzo mail depositato.

24

Titolo del Corso: **Contaminazione ed ecotossicologia nel suolo**
Docente: **Dott.essa Arianna De Bernardi**

Ore complessive :12 = 2 CFU
Date proposte: Da definire (luglio-settembre)
Programma:

Argomenti	Ore
1. Introduzione all'ecotossicologia ambientale, endpoint ecotossicologici e cenni di regolamentazioni europee. Organismi bioindicatori edafici, focus sui saggi ecotossicologici standard e tecniche innovative per la valutazione dello stato di salute del suolo.	3
2. Laboratorio - Allestimento di un Test Avoidance con lombrico *Eisenia Fetida.*	3
3. La contaminazione del suolo (principali contaminanti e fattori che ne influenzano la biodisponibilità concetti di accumulo nelle catene trofiche).	2
4. Laboratorio – Visualizzazione dei risultati dell'Avoidance Test.	4

Modalità di svolgimento: Teams o in presenza per due lezioni frontali (argomenti 1 e 3), solo in presenza per le lezioni pratiche in laboratorio (argomento 2 e 4).

25

Titolo del Corso: **Agricoltura di Precisione. Applicazioni nel campo della meccanizzazione agricola**
Docente: **Prof. Ester Foppa Pedretti**

Ore complessive :12 = 2 CFU

Date:
- 27 agosto 2024, 09:00 – 13:00
- 28 agosto 2024, 09:00 – 13:00
- 29 agosto 2024, 09:00 – 13:00

Programma:
Introduzione all'agricoltura di precisione; fattori limitanti e favorevoli la sua diffusione nel contesto produttivo globale ed italiano.
Importanza dei dati e loro tipologia; applicazioni in agricoltura: sensori, misure e applicazioni
Casi studio

Modalità di svolgimento
Le lezioni si svolgeranno in presenza

26

Titolo del corso: **Biologia di *Apis mellifera* e tutela della biodiversità - Honey bee biology and biodiversity protection**
Docente: **Prof.ssa Sara Ruschioni**

Ore di lezione: 12 (2CFU)

Programma:
- Api ed impollinazione
- Morfologia e anatomia di *Apis mellifera*
- Biologia dell'alveare: sviluppo e compiti delle api
- Fisiologia sociale di *Apis mellifera*
- Cenni di apicoltura
- Importanza delle api per la tutela della biodiversità

Program:
- Bees and pollination
- Morphology and anatomy of *Apis mellifera*
- Hive biology
- Social physiology of *Apis mellifera*
- Basics of beekeeping
- Importance of bees for the protection of biodiversity

Modalità di svolgimento: **in presenza (Aula e apiario didattico)**

Date:
- lunedì 3 giugno 2024 dalle 9 alle 13;
- mercoledì 5 giugno 2024 dalle 9 alle 13;
- venerdì 7 giugno 2024 dalle 9 alle 13.

27

Titolo del Corso: Introduzione all'analisi multivariata dei dati e spettroscopia NIR / Introduction to multivariate data analysis and NIR spectroscopy

Docente: Dott.ssa Manuela Mancini

Total hours: 24 = 4 CFU

Course aim: The purpose of the course is to give an introduction to some of the common methods in multivariate data analysis and give the students tools and knowledge to understand and perform PCA data analysis on their own data. The course is designed also to provide theoretical and practical knowledge of near-infrared spectroscopy (NIRS) and its possible applications.

Learning outcomes and competences:

At the end of the course the students should be able to: describe the principles of NIR spectroscopy as well as to summarize its possible applications. They will be able to perform lab analysis on samples using NIRS sensor. They will arrange data in a matrix appropriate for PCA. They will obtain theoretical knowledge about the principals of PCA (exploration) and apply PCA on new data and analyze the results.

Program:

The course will cover the following topics:

1. Fundamentals of NIRS
2. Instrumentation: theory and hands-on experience
3. Introduction to the chemometric methods, Principal Component Analysis (PCA), including common data pre-processing
4. Computer exercises

Course schedule:

The students will participate to class lectures (ca. 12 hours) and group work based on hands-on laboratory and computer assignments (ca. 12 hours).

Schedule:

The course is taking place on Spring 2024.

Course enrolment: enroll to Manuela Mancini (manuela.mancini@staff.univpm.it) Jul 30th at the latest.

Room: tbd based on the number of PhD students

28

Titolo del Corso: Coperture multifunzionali e risposta fisiologica dell'albero - Multifunctional covers and physiological response of the tree

Docente: Prof. Davide Neri

Total hours: 8 = 1.3 CFU

The installation of anti-hail nets is widespread in orchards to ensure protection against hailstorms and to have more profitable production and quality of fruit. Anti-hail nets can influence several

environmental factors: light, airflow, temperature and humidity. Furthermore, the nets can prevent physical contact of the insect with the fruit and help greatly reduce the use of chemical sprays, especially close to the harvest period. Today in table olive groves and orchards the effect of the use of nets has been positive on: a) the control of the olive fly, of the codling moth on apple and pear trees and of Drosophila suzukii on cherry trees and berries; b) management of the orchard of deciduous fruit trees both to induce changes in the physiology of the plant, in the growth and quality of the fruit, and to prevent sunburn of the fruit. A special (waterproof) mesh system is also used to control rain contact with the canopy and fruit. This is especially true for cherry production, which is very sensitive to fruit cracking.
The course will present specific changes in photosynthesis, plant growth, fruit quality and production in orchards due to the use of different types of network systems including photoselective networks also in relation to climate crisis mitigation. Photoselective mesh involves the application of differential filtration of solar radiation with color elements incorporated during manufacturing to differentially absorb UV, visible and near-infrared (NIR) wavelengths. Special network systems can transform direct light into diffused/scattered light. Although the net reduces the total amount of underlying light, the photoselective and dispersive net can increase the availability of light in the inner canopy and stimulate photosynthesis in the external layers counteracting outside excess light, photoinhibition and improving fruit productivity and quality. An important aspect of plastic thread characteristics is UV degradation, which is a form of polymer degradation that affects plastic exposed to sunlight. The problem presents net degradation as fading or discoloration, cracking, loss of strength, or disintegration. Degradation effects increase with exposure time and sunlight intensity. The addition of UV absorbers inhibits UV degradation. The spectrum of each net system is important for the physiological vigor and productivity of the plant. Growers may need to adapt their agrotechnical practices to compensate for the increased growth rate (e.g., intensifying fertigation, plant spacing, increasing net height) to avoid nutrient deficiencies, excessive shading and maintain optimal light and microclimatic environment.

29

Titolo del Corso: Ecofisiologia della radice nei sistemi arborei intensivi e disturbati - Root ecophysiology in intensive and disturbed tree systems

Docente: Prof. Davide Neri

Total hours: 9 = 1.5 CFU

Intensive fruit and olive production systems are characterized by increasing planting density, early fruiting, small tree size, high crop loads, short orchard duration, easy mechanical management and frequent replanting. Therefore, achieving consistently high fruit quality depends not only on the efficient management of canopy architecture from nursery to orchard, but also on root behavior and soil fertility. Environmental sustainability requires soil management practices to increase and maintain fertility, such as minimal tillage, multispecies ground cover, and the provision of soil amendments. Innovation in crop management regimes implies strategies to control plant and root development that can optimize and simplify orchard management. Achieving these objectives requires the active participation of farmers, technical advisors and extensions services.
Intensively managed orchards rely on endogenous plant resilience mechanisms. **The course will present the plasticity of roots in their responses to external stimuli which determines stress tolerance** and must be promoted by growers. The root system of the high-density orchard can respond readily to changing conditions. Therefore, it has become critically important to explore soil-plant relationships and highlight management practices that promote root development, response to the climate crisis, and different irrigation and fertilization systems. This applies

especially to the fibrous fraction of the root, which is most active in absorption, as well as root activity and lifespan. Furthermore, for intensive orchards and disturbed tree systems that are highly exposed to replanting conditions, sustainable management should prevent the accumulation of homospecific residues, possibly accelerating the degradation cycles of allelopathic compounds and humicafication processes. The course summarizes a series of studies conducted to determine the effects of soil fertility, organic crop residues and amendments on the morphology and physiology of tree roots, and highlights the importance of soil management practices in promoting efficient development of the tree roots in different growing condition.

30

Titolo del Corso: Genetics, Biotechnology and Biosafety for plant genetic improvement

Docente: Prof. Bruno Mezzetti

Total hours: 12 = 2 CFU
Date: to be defined on the 2nd and 3rd week of June.

Themes:
- Traditional breeding
- Mutation technology
- Biotechnology applications in horticultural crops
- Biosafety rules and methods of study
- Case studies

31

Titolo del Corso: Basics of the GEOBIA Approach in Remote-sensing Data Analysis on eCognition and Applications on forestry and agriculture

Docente: Dr. MD Abdul Mueed Choudhury

Total hours: 12 = 2 CFU

Program: The course will primarily concentrate on the Geographic Object-Based Image Analysis (GEOBIA) methodology, specifically in the context of territorial analysis for the mapping and estimations of ecosystem services provided with sustainable landscape planning. It will introduce participants to the Trimble eCognition platform, which will serve as the foundation for applying the basic principles and techniques of GEOBIA. These include image segmentation, object characteristics, as well as supervised and rule-based classification methods. Overall, the program will be provided with the following features:
- Introduction to eCognition and case studies on GEOBIA;
- Object features, i.e., vegetative and non-vegetative (LCLU) indices;
- Intro to ruleset development and algorithms;
- Segmentation i.e., types, uses, applications;
- Classification based on data properties (Thematic and Raster);
- Accuracy assessment, validation, and export results;
- Rule-set Development for land cover and vegetation (Plant health, ecosystem services) analysis.

Objectives of the course:

Upon completion, attendees ought to grasp the fundamental concepts of GEOBIA and possess the capability to execute a GEOBIA workflow using the eCognition remote sensing software package.

Prerequisites: Basic computer applications and physics.

Course schedule: Approximately in June/July 2024.

Room: To be updated.

N.B. The medium of instruction will be in English for the entire course. Materials could be available in Italian on request.

32

Titolo del Corso: Physiologically-Based Models supporting the management of insects

Docente: Dott. Giorgio Sperandio

Ore complessive: 12 = 2 CFU

Course aim

The goal of this course is to provide essential knowledge about the development of Physiologically-Based Models emphasizing their role as decision-support tools in pest management. Students will have the opportunity to explore the principles of the physiologically-based approach, understand key steps of model development, and learn proper techniques for collecting and managing biological data used for model calibration and validation. The course will feature various case studies demonstrating how physiologically-based models are developed and applied for the management of insect pests across diverse contexts, from Pest Risk Analysis to Integrated Pest Management. Additionally, students will participate in a practical test involving the management of biological data and the development of a basic predictive model.

Program

- **Concepts of modelling applied to insect management**: definition of model and introduction to their use
- **The physiologically-based modelling approach**: principles of physiologically-based models in the context of insect pest management
- **Development of a model**: definition of the main steps of model development, and use of data for simulating the individual physiology and the population dynamics of insects
- **Case studies**: application of models in the context of pest management
- **Practical test**: development and application of a simple physiologically-based model

Course schedule:

08/05/2023: 10:00 – 13:00
10/05/2023: 10:00 – 13:00
15/05/2023: 10:00 – 13:00
17/05/2023: 10:00 – 13:00