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Applied statistics and physics (9 CFU)

Applied Statistics (4 CFU)

The overall course goal is to introduce the basic concepts of statistics, demonstrate methods of exploring, organizing, and presenting data, and introduce the fundamentals of probability.

Syllabus: The role of statistics and data analysis in life science. An introduction to experimental design. Graphical methods for describing data. Numerical methods for describing data. Introduction to probability and distributions. Hypothesis testing. Comparing populations or treatments. Simple linear regression and correlation. Introduction to the analysis of variance and to the analysis of contingency tables. Nonparametric (Distribution-Free) statistical methods.

Physics (5 CFU)

The course aims to provide the students with the rudiments, necessary for learning Physics, with the use of logic and calculus and through the solution of problems or case-studies linked to subjects specific to the area of agricultural and food science.

Syllabus: Operative definition of physical quantities. Units of measurement. Systems of measurement. Fundamental and derived quantities. Conversion of quantities. Scientific notation. Scalar and vector quantities. Concepts, principles and problem solving in kinematics, dynamics, work and energy, fluids and thermodynamics.

Chemistry (10 CFU)

Inorganic Chemistry (5 CFU)

The course introduces the student to the matter structure and to its possible chemical and physico-chemical transformations. The processes are deepened of the electronic configuration of atoms and molecules, of the nature of the chemical bond, chemical equilibrium, acidity and pH.

Syllabus: Inorganic compounds. Stoichiometry. Atomic structure. Chemical bonds. Geometry and polarity of molecules. The states of matter. Gas laws. Liquids properties. Phase changes. Chemical equilibrium. Le Chatelier principle. Brønsted-Lowry acids and bases Lewis acids and bases; pH of saline solutions. Buffer solutions, titrations.

Organic chemistry (5 CFU)

Students will develop a logical understanding of the properties and behavior of organic molecules by learning about their reaction mechanisms, their steric and electronic effects, resonance etc.

Syllabus: Aliphatic and aromatic hydrocarbons. Alkanes and cycloalkanes: alkenes, alkynes and dienes. Aromatic compounds. Compounds containing a σ bond C-Z; stereochemistry. Alkyl nucleophilic substitution and elimination reactions. Alcohols, phenols and ethers. Quinones and biological oxidation-reductions. Amines. Compounds containing the carbonyl group. Aldehydes and ketones: structure of the carbonyl group and nomenclature of aldehydes and ketones. Nucleophilic addition to a carbonyl group. Carboxylic acids and functional derivatives. Di- and tri-carboxylic acids, hydroxyl-acids and keto-acids. Aromatic heterocyclic compounds. Fats and oils. Waxes and phospholipids.



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Plant Physiology and Genetics (9 CFU)

Plant Physiology (4 CFU)

The course aims to illustrate the characteristics of plant cells, tissues, organs, and the endogenous and environmental factors that regulate growth and development.

Syllabus: The plant cytology and anatomy of the primary and secondary body of roots, stems and leaves. Plant reproduction systems, differentiation of stem, leaf, root, flowers, seed and fruit. Mechanisms of plant life including transpiration, long distance transport, environmental stimuli and growth regulators. The use of optical microscope for observation plant tissues and the primary and secondary body of roots, stems and leaves. General criteria of systematics and characteristics of the principal families of food interest using guides and herbarium.

Applied Genetics (5 CFU)

The course is about concepts and practical skills covering the fundamental elements of genetics of eukaryotic organisms.

Syllabus: DNA structure, replication and organization. The connection between DNA and proteins: transcription, translation and mechanisms of regulation of gene expression. The origin of genetic variability: segregation, recombination, mutations (gene, chromosome and genome mutations). The inheritance of genes: from mendelian traits to quantitative traits. Studying genomes, transcriptomes and proteomes. The methodologies for DNA and genome analysis. The applications of molecular methodologies to biodiversity and traceability studies.

Biochemistry (8 CFU)

Biochemistry (4 CFU)

Students will acquire general knowledge respect to metabolic network and information on main primary and secondary metabolites.

Syllabus: Enzymatic catalysis: thermodynamics, kinetics and regulation at the substrate level and biosynthesis. Integration of metabolic networks. Biological membranes and solute transport: thermodynamics, kinetics and specificity of transport. Primary metabolites (carbohydrates, amino acids, proteins, nitrogenous bases, lipids). Secondary metabolites (terpenes, phenols, alkaloids).

Applied Biochemistry (4 CFU)

Students will acquire a theoretical grounding in the principal biochemical processes, both catabolic and biosynthetic, of higher organisms related to nutrition and to the principal biochemical processes of the soil-plant-biota system.

Syllabus: Glycolysis and its regulation: Aerobic and anaerobic conversion of pyruvate; Pentose phosphate pathway; Krebs cycle Mitochondrial electron transfer and oxidative phosphorylation and coupling. Photosynthesis: Conversion of light energy into chemical energy; The photosynthetic apparatus; Photosynthetic electron transport and photophosphorylation; Fixation of CO₂; Calvin cycle; C₂, C₃, C₄, CAM metabolism; Synthesis of sucrose and starch. Nitrogen metabolism: Nitrogen cycle; Metabolism of amino acids; Assimilation of GS/GOGAT ammonia; Transamination; Cori cycle; Glucose-alanine cycle; Catabolism of amino acids, urea cycle. Lipid metabolism: Biosynthesis of fatty acids, β -oxidation of fatty acids, glyoxylate cycle and gluconeogenesis. Unsaturation of fatty acids and biosynthesis of triglycerides (triacylglycerols).



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Applied agronomy and horticulture (8 CFU)

Applied Agronomy (4 CFU)

This course provides a basic understanding of the science and practical applications regarding the main factors affecting crop production and the main principles of crop physiology and how these principles can be applied to agricultural systems.

Syllabus: Role of agronomy and crop science; crop physiology and agricultural systems. The soil; Chemical, physical, and biological properties, residue management, water and solute movement, soil/plant water relations, irrigation, drainage, soil conservation, soil quality. Cropping systems. Tillage, planting practices, crop growth, development, harvest and storage, precision farming. Plant nutrition and soil fertility. Nutrients, the nitrogen cycle, liming and soil amendments, fertilizers, manure, cover crops, fertilizer calculations, nutrient application.

Horticulture (4 CFU)

The course aims to provide students with the fundamental scientific, technical and operational knowledge relating to the planting and management of fruit tree orchards.

Syllabus: Anatomy and morphology of fruit tree species. Fundamentals of fruit tree biology and physiology. Behavior of fruit tree species vs. main abiotic stresses (light, thermal, hydric). Woody plant propagation. Rootstocks, orchard planting and management, including orchard design, floor management, trellising, pruning, harvesting and post-harvest techniques.

Food economics (10 CFU)

Fundamental in Economics (5 CFU)

The course covers the fundamentals of economic analysis, which will enable students to interpret situations using the tools of economic science, both at the level of individual actors (firms, households, state) and of the economic system as a whole.

Syllabus: The course covers both microeconomic topics (consumer theory, firm theory, competition and market structure) and macro-economic topics (economic growth, inflation, unemployment, fiscal and monetary policies). This material is a prerequisite for the subjects encountered in subsequent years, dealing more in depth with the economic aspects of the agri-food system.

Agri-food Economics (5 CFU)

The course describes the principal problems and the organisation of the agri-food system to help students understand how the characteristics of the final food product are the result of strategies implemented at various stages of the supply chain, of the forms of coordination adopted and the policies put in place. Students will be provided with an introduction to agrifood markets and will be shown how the different stages along the food supply chain work and relate to each other.



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Applied Agri-food Microbiology (6 CFU)

The aim of the course is to provide the basic and specific knowledge of microbiology applied to the agricultural and food sectors. The student will be familiar with several microbial groups of agri-food interest, he will be able to propose specific strategies for searching, selecting, typing and collecting microorganisms for possible significant applications in food productions. The student will be also able to perform lab methods to detect microorganisms in food and feed matrices and to analyze genomic data.

Syllabus: The fashionable structure of the prokaryotic cell. How bacteria move and face adverse conditions. Pure culture, type strain and preservation of bacterial cells; international collections, industrial culture collections. Bacterial metabolism: Mathematics of bacterial doubling, nutritional groups, culture media, transport systems, energy metabolism or catabolism, fermentation, biosynthetic pathways. Food composition and microbial growth/spoilage, physical structure affects the course and extent of spoilage, presence and availability of water, extrinsic factors. Microbial fermentations, natural starter cultures, industrial fermentations, meat products, dairy products, bakery products, fermented beverages, vegetables. Classical or phenotypic taxonomy, phylogenesis, genotype-based classification methods, microbial phyla relevant for the agri-food sector. Microbiological aspects of plant productions, microbiology of animal feed, bioenergy production, ecology of fungi, fungi of relevance to the agri-food industry and overview of the principal groups, yeasts and genetics. Techniques to isolate and identify a microorganism; PCR and its applications in microbiology, sequencing, genomic analysis, metagenomics and study of complex bacterial communities.

Food Technology (9 CFU)

Principles of Food Processing Technology (5 CFU)

Course aims to provide basic knowledge of principles of food processing and related technologies, covering general characteristics of raw food materials, principles of food preservation, processing factor that influence quality, packaging, water and waste management, and sanitation.

Syllabus: Introduction to food technologies and food processing. Thermal processing principles. Non thermal treatments. Processes for the reduction of water content in foods. Overview on shelf-life, storage and packaging aspects. Principles of sanitation, energy, water and waste management in food processing.

Sensory Evaluation (4 CFU)

Students will be introduced to sensory analysis techniques and provided with elements for statistical evaluation of sensory tests.

Syllabus: Sensory attributes of beverages and food and their perceptions. The senses and the sensory receptors, the language of sensation. Preparation of tasters and tasting panels. Consumer science.



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Crop Protection (9 CFU)

Entomology (3 CFU)

Primary goal of the course is to provide the student with the basic knowledge necessary to recognize the major pests of crops, to learn the relationships between crops and insects (pests and beneficials) and to optimise pest management strategies.

Syllabus: Anatomy and physiology of insects will be considered in the framework of potential of damage to agricultural production and taking into account plant and environmental protection. The behaviour and communications within and among species will be studied and their potential as innovative pest control strategies will be exploited as part of Integrated Pest Management strategies. The use of insecticides will be critically evaluated studying their mode of action, selectivity, and resistance issues in an Integrated Production perspective. In the second part of the course insect classification will be considered focusing mainly on morphological and biological features of most economically important crop pests and beneficials.

Plant Pathology (6 CFU)

Primary goal of the course is to provide the student with the basic knowledge necessary to recognize the major crop diseases, learn the basis for their diagnosis and acquire the skills for their control.

Syllabus: Introduction to plant pathology: from the disease concept, to disease classification and their diagnosis. Main characteristics of causal agents (bacteria, viruses, fungi, phytoplasmas and viroids) will be described, Koch's postulates and main methods for diagnosis will be presented. The infection process will be studied and the infection cycle (inoculation, penetration, incubation, evasion and dissemination) as well as the disease cycle (monocyclic and polycyclic diseases) will be analysed. During this class host-pathogen interaction will be faced and the effect of environmental factors (i.e. weather, edaphic and agronomic factors) will be briefly studied. Disease control is the last part of the course with specific emphasis on treatment against the causal agent (i.e. preventative, curative and eradicator treatments) as well on the host (i.e. genetic improvement) or on the environment (i.e. mitigation measures).

Animal Science (9 CFU)

Animal Physiology (4 CFU)

The objective of the course is to introduce students to the basic principles of animal physiology by comparing physiological processes in monogastric and ruminant livestock species.

Syllabus: Anatomy and physiology of the digestive processes. Metabolic utilization of nutrients in the productive processes. Endocrine system and the functions of the main metabolic hormones. Anatomy, morphology and physiology of the reproductive system (estrous cycle) of females. Anatomy and morphology of the mammary gland; physiology of the lactation (from lactogenesis to ejection of milk)

Applied Animal Science (5 CFU)

The course aims at training students on the feed nutritional value when entering the diet and its synergy with other feeds in meeting the animal needs for growth and production.



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Syllabus: Water and nutrients contents of feeds. Feed evaluation systems of main use in livestock rearing. The nutritive values of feeds. Proper use of feeds for maximizing the nutrients efficiencies and quality of animal products in livestock breeding with minimal effects on environment.

Sustainability and Food Law (10 CFU)

Food Law and Certification (5 CFU)

The course's goal is to introduce students to the regulation of foodstuffs, highlighting not only the interplay between the domestic and international regulatory layers, but also food law's complex structure, characterized by the interaction between public norms, private standards and certifications.

Syllabus: Food safety. International food standards. Quality, including the protection of geographical indications. Information, with specific regard to labelling, nutritional claims and health claims. Standards, certifications and other contractual arrangements employed to manage agro-food chains. Regulatory mechanisms to promote (economic, social, environmental) sustainability. Protection of innovation, with regard to patents, plant variety and other sui generis rights.

Economic and Environmental Sustainability of Agriculture (5 CFU)

The course introduces to economic theories and relationship between the economic system and the environment.

Syllabus: Circular economy and sustainability. The optimal use of renewable natural resources in different management conditions (profit maximization, free access, common property, presence of externalities like the value of biodiversity). Policy implication with respect to the agri-food sector. Economics of pollution and the role of agri-food sector: economic tools for intervention and policy implications. Principles and tools for the economic evaluation of environmental goods and ecosystem services (implication for the agri-food sector and policies). The evolution of the Common Agricultural Policy (CAP) and its effects on relationships between the agricultural sector and the environment. Rural development policies and agro-environmental policies. Environmental certifications and sustainability.

Food Safety (8 CFU)

Biological Safety (5 CFU)

The general aims of this course will be to illustrate the European approach to food and feed risk analysis and to provide the basic and technical knowledge on food processing and hygiene.

Syllabus: The European risk analysis approach: risk assessment and risk management, the steps of risk assessment, the risk management in the food chains: the concept of ALARA, ALOP and FSOs, the food risks, biological and chemical hazards. Legal rules, the RASFF (Rapid Alert System for Food and Feed) system in EU, the role of EFSA, principle of prevention, Risk Management in the food chain. Antimicrobial resistance: a major EU and global challenge. Basic of food processing hygiene criteria: The Good Manufacturing and Hygiene Practices (GMP-GHP), the HACCP: concept and application, prerequisites, the decisional tree for CCP identification, the corrective measures, examples of HACCP plans. Animal feed hygiene: Feed materials, feed additives, compound feed, legislation, official controls, genetically modified feed. Microbiological Quantitative Risk Assessment: The regulation on Microbiological Criteria, the microbial food spoilage: bacteria and fungi, food-borne infections and intoxication,



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food-borne pathogens and control measures, the EFSA report on trends and sources of zoonosis, antimicrobial resistance. Basic terms and concepts of food technology: Thermal preservation of food, non-thermal processes for food processing: the cold chains, acidification and fermentation.

Chemical Safety (3 CFU)

Students will gain an in-depth knowledge of the principles for assessing the risks arising from consumers' exposure to chemical contaminants potentially present in food. They will learn the general principles on the nature of chemical contaminants, their occurrence, and the corresponding risk management.

Syllabus: Contaminants and food security, risk perception and communication. Concepts of prediction, monitoring and risk assessment. Information and risk management. Contaminants' chemical nature (heavy metals, pesticides, polycyclic hydrocarbons, dioxins, flame retardants, phthalates etc.), sources and life cycle. Persistent pollutants, bioaccumulation. Emerging pollutants. Mixtures. Food contact materials and migration.

The wine trail

Applied Viticulture (6 CFU)

Students will acquire fundamental knowledge as it concerns grapevine morphology and applied ecophysiology achieving skills to address vineyard management.

Syllabus: Origin and taxonomy of *Vitis* spp. Botany and anatomy. Phenology and growth cycle. Reproductive cycle: bud differentiation, blooming and fruit-set. Grapevine varieties: classification, biodiversity, and breeding. The use of rootstocks in viticulture. Grapevine physiology: factors affecting plant growth, gas-exchange, water relations and leaf-to-fruit balance. Berry development and ripening. General overview on vineyard management: training systems, canopy management, mineral nutrition and floor management, harvest.

Applied Enology (6 CFU)

Students will be introduced to winemaking techniques and provided with fundamentals of wine composition, microbiology, plants and equipment.

Syllabus: Wine Chemistry: sugars, acids, polysaccharides, nitrogenous material, enzymes, phenolic substances. Wine Microbiology: alcoholic fermentation, malolactic fermentation, wine spoilage and related microorganisms. Winemaking and wine styles: processes for white and red still wines, sparkling and passito wines.

Integrated Vineyard Protection (6 CFU)

Primary goal of the course is to provide the student with the knowledge for recognize the main grapevine diseases, learn the basis of their diagnosis, acquire the skills for understand, develop and apply an integrated management strategy.

Syllabus: definition of disease management in the vineyard, with the classification of key diseases (endemic and epidemic) and occasional diseases. A detailed description of the key diseases (downy and powdery mildews, grey mould, esca disease, black rot, yellows group diseases and viruses) will be provided with symptoms, biology, diagnosis, life cycle, epidemiology and yield losses. Basic knowledge will be provided about fungicides, their physical mode of action, application methods and anti-resistance strategies. Integrated disease management will be deeply analysed according the eight general principles of IPM with particular emphasis on disease forecast, monitoring and application of management practices (from non-chemical to bio-control agents and fungicides application).



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Tomato, pasta and bakery hub

Vegetable Production and Technology (6 CFU)

The course provides a general grounding in the principal features of Italian horticulture.

Syllabus: Economic significance and distribution of the main horticultural species. Requirements, botanical characteristics, and varietal selection. Growing methods and systems employed in open field, protected, and soilless cultivation. Integrated and organic crop protection systems. Nutritional, commodity, and quality aspects of productions intended for the fresh and processed foods markets. Post-harvest physiology, and methods of conditioning, storage, and industrial processing. Description of the main species with emphasis on Solanaceae (tomato, potato, pepper, aubergine), Liliaceae (asparagus, onion, garlic), Compositae (artichoke, red chicory, and lettuce) and Cucurbitaceae (courgette and pumpkin).

Cereal Grain Production, Processing and Baking Technology (12 CFU)

Cereal Grain Production (6 CFU)

The learning objectives are cereal grains, with special emphasis on common and durum wheat, essential to dietary needs as well for industrial processing. Grain quality at all stages of the grain chain, from breeding to production, harvesting, storage and finally processing into foods.

Syllabus: Cereal grain morphology and composition. Cereal grain characteristics and quality requirements. Identification of grain quality varieties and quality types. Food safety aspects of grain and cereal products. Concepts of agronomy, breeding and physiology for grain quality traits.

Grain Processing and Baking Technology (6 CFU)

Course provides basic knowledge of the science of bakery products including ingredients production and their characteristics, processing technologies for bread and non-bread products, and quality control.

Syllabus: Introduction to baking and bakery products. Flours (wheat and other cereal grains milling and flour quality evaluation). Other baking ingredients (water, yeast and other leavening agents, sugar and sweeteners, lipids, eggs, dairy ingredients, enzymes, other functional additives). Baking technologies (for bread and other products including cakes, biscuits, pastries, pretzel). Quality control, packaging and shelf-life. Overview on nutritional aspects and functional bakery products.

Cheese and cured meat hut (18 CFU)

Milk and Meat Production and Technology (12 CFU)

Milk and Meat Production (6 CFU)

The monitoring of the herd and the animal performances, the automation and the precision feeding in livestock farming and the quality of animal products are keys solutions for the modern livestock breeding.

Syllabus: Scientific and technical skills in livestock production (milk, meat and pork). The management and the feeding techniques in ruminants and monogastric rearing will be addressed for animal performance optimization, including aspects on animal health and welfare, and for a sound product quality and environmental benefits.



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Technology of Animal Chain Products (6 CFU)

The aim of this module is to improve the knowledge about the technology of transformation and milk and meat quality for the principal Italian PDO cheeses and cured meat.

Syllabus: Management of milk and meat quality. Genetic and environmental factors affecting milk and meat quality. Milk cheese making properties. Pig carcass classification and the main meat problems (PSE and DFD). PDO products: The principal cheeses and meat PDO product in Europe and Italy. The rules of Parma and S. Daniele ham consortium. The rules of Grana Padano and Parmigiano Reggiano cheeses. The processing for Grana PDO cheeses and cured Italian meat: the PDO ham production and other Italian Cured PDO products.

Microbiology of Dairy and Meat Food (6 CFU)

This course is aimed to provide to the student the principles of food microbiology with particular emphasis on dairy and meat sectors. The contents will space from the study of microorganisms behaviour in food to the safety of productions, with some hints on regulation. The student will be also able to apply analytical cultivation-dependent and independent methods and will take part in practical tour to dairy and meat companies.

Syllabus: Factors influencing the survival and growth of microbial communities in foods, food composition, physical structure, water availability, extrinsic factors (temperature, oxygen, pH). Microbiota of fermented foods: Methods for identification of microbial species and populations; adventitious, naturally-present, and selected cultures for food fermentation. In-depth study of pathogenic bacteria in food products, food-borne diseases, food-borne infections, food intoxications, emergent pathogens, detection of food-borne pathogens. Food safety regulation: quantitative microbiological risk assessment for food products, management of microbiological risk in the food production supply chain: the EU Regulation on Microbiological Criteria for Foodstuffs. Food spoilage in dairy and meat products: how microorganisms take advantage of food nutrients. Microorganisms as agents of food deterioration, key factors for controlling microbial spoilage, microbial product-based inhibition (bacteriocins, protection cultures). Overview of microorganisms for the production of enzymes and ingredients for the food industry, genetically modified microorganisms (GMM) in the food industry. Microbiological analytical methods for dairy and meat industry.

Free programs (12 CFU)

Biomass Waste Management (4 CFU)

Students will learn about the biomass waste management, the legislation in force, the source of biomass mainly from agri food system. Students will learn about analysis methods used to determine the chemical-physical and biological characteristics of biomass.

Syllabus: Residue and waste. Legislation. Civil and industrial waste waters. Sewage sludges. Urban, industrial, agricultural, agri-food biomasses. Fertilisers and organic amendments. Composting. Composting process technologies. Mixed compost and compost from solid municipal waste. Soil amendments and fertilisers from animal husbandry and agri-food industry waste. Recovery of energy from waste. Biogases. Incinerators with energy recovery.



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Fruits and Nuts (4 CFU)

The course aims to provide students with the scientific, technical and operational knowledge relating to the main pome fruit, stone fruits and nuts.

Syllabus: Apple, Pear, Peach, Cherry, Hazelnut, Almond and Walnut. Overview of propagation, production and handling systems, analysis of current cultural and harvesting problems and concerns associated with commercial fruit growing.

Food Marketing (4 CFU)

Objective: with this course, students will obtain theoretical knowledge and practical ability with the main marketing tools in the fields of agriculture, food industry and food retail.

Syllabus: The marketing environment of agri-food businesses. Food consumer behavior, market analysis and market segmentation. Marketing strategy and planning. Marketing mix: product, price, distribution and communication tools. Marketing tools for retailer. Trade marketing.

Soil Health and Biodiversity (4 CFU)

Students will acquire the fundamental ideas relating to the genesis and classification of soils, to the chemistry of the organic and inorganic soil components and their interaction in the soil-plant system, and plant nutrients and the biodiversity of soil.

Syllabus: Soil System and holistic view of soil health. Soil and environment, fluid phases of soil, elements of fertility. Soil degradation. Desertification, erosion and pollution. Soil biodiversity. Organism living in the soil.