Università degli Studi di Perugia
Dipartimento di Chimica, Biologia e Biotecnologie
Dipartimento di Scienze Agrarie, Alimentari e Ambientali

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Città di PERUGIA

11 – 12 giugno 2025
Sala dei Notari Perugia

Abstract Book

PhD in Biological and Natural Sciences
PhD in Agricultural, Food and Environmental Science and Biotechnology

Summer School 2025

Environmental and human well-being: from basic to applied research

https://www.dcbb.unipg.it/en/workshop-home

Program

11 June 2025

8:00 Registration

Welcome and Opening of the Congress

9:15 Welcome by Prof. Alceo Macchioni, Director of the Department of Chemistry, Biology and

Biotechnology, University of Perugia

9:25 Welcome by Prof. Gaetano Martino, Director of the Department of Agricultural, Food and

Environmental Sciences, University of Perugia

9:35 Welcome by Prof. Emidio Albertini, Coordinator of PhD Course in Agricultural, Food and

Environmental Science and Biotechnology, University of Perugia

9:45 Welcome by Prof. Manuela Rebora, Coordinator of PhD Course in Biological and Natural

Sciences, University of Perugia

CHAIRS: PAOLO PASTORINO, DANIELE DEL BUONO

10:00 Damia Barcelo - Emerging contaminants and microplastics: risks and challenges for water quality and food under water scarcity.

Department of Chemistry, and Physics, University of Almeria, Spain

10:30 Monia Renzi - The role of ecotoxicological analysis to support environmental protection,

human health, and production chains.

Dipartimento di Scienze della Vita, University of Trieste, Italy

11:00-11:30 BREAK

CHAIRS: SILVANA PIERSANTI, LORENZO RAGGI

11:30 Riccardo Guarino - Land use change and loss of biodiversity

Dipartimento STEBICEF, University of Palermo, Italy

12:00 Simona Bonelli - Decline of butterflies and other pollinators and the challenge of the 2030 European target

Dipartimento di Scienze della Vita e Biologia dei Sistemi, University of Torino, Italy

12:30-15:30 LUNCH

CHAIRS: ROBERTO ROMANI, PIETRO BUZZINI

15:30 Priscilla Farina - Centuries of botanicals in arthropod pest control, but something is still

missing

Department of Agriculture, Food and Environment, University of Pisa, Italy

16:00 Ivan Marchesini - Modelling and forecasting landslides occurrence at regional/national scale

CNR, Istituto di Ricerca per la Protezione Idrogeologica, Perugia, Italy

16:30 Enrico Brugnoli - Climate change and the carbon cycle: implications for agriculture and

forest ecosystems

CNR, Istituto di Ricerca sugli Ecosistemi Terrestri - IRET, Porano (TR), Italy

17:00 Ingrid Garbus - Non-coding RNAs in Environmental Stress Responses

CERZOS/CONICET, Argentina

Argentina

12 June 2025

CHAIRS: ILARIA BELLEZZA, BERNARDO VALENTI

9:00 Luis Pardo - Role of ion channels in cancer

Oncophysiology Group, Max Planck Institute for Multidisciplinary Sciences, City Campus,

Göttingen, Germany

9:30 Elvio Lepri - Animals as sentinels for environmental health: the role of veterinary oncology

Dipartimento di Medicina Veterinaria, University of Perugia, Italy

10:00 Cristian Gallo - Leveraging satellite data and machine learning for agricultural and

environmental insights

CONICET Argentina

10:30 Andrea Rosati - Artificial Intelligence in Livestock Farming

European Federation of Animal Science – EAAP, Rome, Italy

11:00-11:30 BREAK

CHAIRS: GIAMPIERO MARCONI, ERMANNO FEDERICI

11:30 Sara Zenoni -Genome editing confers disease resistance in grapevine for a healthier

agriculture

Department of Biotechnology, University of Verona, Italy

12:00 Marco Verani e **Ileana Federigi** -Wastewater reuse: balancing sustainability and human

health risks

Laboratory of Hygiene and Environmental Virology, Department of Biology, University of Pisa, Italy

12:30-15:30 LUNCH

16:45-19:00 Tavola rotonda

Produzione e sostenibilità ambientale: un binomio compatibile?

Massimiliano Trevisan, moderatore

Costanza Spera, Assessore alle politiche sociali del Comune di Perugia

David Grohmann, Assessore all'Ambiente e Rigenerazione Urbana del Comune di Perugia

Thomas De Luca, Assessore all'energia, all'ambiente, all'adattamento e mitigazione dei

cambiamenti climatici, alle politiche del paesaggio e alla programmazione urbanistica di Regione Umbria

Matteo Minelli, Birrificio Flea

Valentina Dugo, Consorzio AVO, Umbria biodiversity

Margherita Tiradritti, Aboca S.p.A. Società Agricola

Gabriele Cruciani, Delegato terza missione Università di Perugia

Andrea Sisti, Presidente autorità Umbra Rifiuti e Idrico (AURI)

Abstract Book

Emerging contaminants and microplastics: risks and challenges for water quality and food under water scarcity

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Plastic pollution is nowadays a global and ubiquitous problem everywhere including the marine environment surface waters, soils, sludges, sediments, biota, food and air. To have an idea how widespread this problem is, over 350 million tonnes are produced every year. River plastic pollution at global scale was estimated between 0.8-2.7 million tons per year. A recent collaborative study performed on 42 rivers and 11 European countries measured during almost two years evaluated the riverine floating macro-litter to the sea. An estimation of 307 and 925 million litter items are released from Europe to the ocean which represent up to 5000 tons/year. Emerging contaminants such as pharmaceuticals, pesticides and perfluorinated compounds are present in rivers globally. Under extreme events pollutants effects on the biota are more relevant that under regular river flow conditions. Water scarcity increased in general the risk of emerging contaminants present in rivers. New type of pollutants like antimicrobial resistance genes (ARG) and microplastics (MPs) are expected to be relevant under climate change scenario. Examples on the risk of these contaminants from Europe, China and Saudi Arabia will be presented in this presentation.

This presentation will focus on the analysis, fate and risks of Emerging Contaminants and MPs in water resources. Risks to the environment and human health combined with the presence of ubiquitous microplastics (MPs) will also be discussed. As regards to the analysis by high resolution mass spectrometric techniques, special attention will be devoted to non-target analysis for screening and identifying Emerging Contaminants and the different analytical techniques for determining MPs.

The role of ecotoxicological analysis to support environmental protection, human health, and production chains

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Ecotoxicology protects the environment, ensuring human safety, and promoting sustainable manufacturing practices. It focuses on the impacts of pollutants and environmental stressors on ecosystems, wildlife, and human health.

Environmental protection requires comprehensive ecotoxicological assessments to identify pollutants that threaten biodiversity and the functionality of ecosystems. By analyzing the interactions between pollutants and different species, risks can be assessed and guidelines developed to minimize exposure to toxic substances to preserve natural habitats and ensure ecological balance for sustainability.

It identifies pollutants that bioaccumulate in the food chain and may pose a health risk, providing data for setting safety thresholds and for public health initiatives aimed at promoting clean production methods and safe consumer products. The inclusion in production processes promotes sustainable industrial practises by identifying safer chemical alternatives. This enables industry to utilise more environmentally friendly technologies, reduce its environmental impact and strengthen its social responsibility.

Global change, including climate change effects like rising temperatures and ocean acidification, is intensifying ecotoxicological issues by altering pollutant toxicity and species interactions. This introduces new risks to biodiversity and human health, necessitating further research and updates to regulatory frameworks.

Ecotoxicological analyses allow a holistic approach to safeguarding environmental health and human well-being. It informs regulatory decisions and industrial practices, deepening the understanding of contamination effects and aiding in the mitigation of their consequences. The connection of scientific findings to policy decisions facilitates informed actions to protect ecosystems and communities, promoting a healthier and more sustainable future consistent with the EU's 2030 targets.

Land use change and loss of biodiversity

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Land use change, driven by industrial agriculture and urban expansion, is a primary driver of biodiversity loss worldwide. The transformation of traditional agroecosystems into intensive monocultures has severed vital ecological relationships, disrupting natural nutrient cycles and degrading the microbiota that sustains soil fertility and human health. Unlike traditional farming, which operated in synergy with ecological limits, today's agro-industrial systems demand continuous external inputs, leading to habitat fragmentation, soil degradation, and the erosion of agrobiodiversity. These changes not only compromise ecosystem services but also threaten food security and human well-being. The concept of *One Health* —which recognizes the interdependence of human, animal, and environmental health— offers a framework to address these challenges. Sustainable land use strategies, grounded in agroecology and regenerative practices, can help restore ecosystem balance and resilience. By prioritizing biodiversity, reducing chemical inputs, and re-establishing the ecological functions of landscapes, we can mitigate the cascading impacts of land use change. Ultimately, reversing biodiversity loss requires a paradigm shift: from exploitation to care, from short-term yields to long-term sustainability, and from anthropocentric to biocentric values.

Decline of butterflies and other pollinators and the challenge of the 2030 European targets

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The ambitious EU Biodiversity Strategy 2030 implemented in the text of the European Restoration Law recognises the scale and urgency of actions needed to halt and reverse declines in biodiversity and a special focus is dedicated to pollinator insects. Reports periodically drawn under the Habitats Directive confirm that many species of European importance are in unfavourable status. Red Lists assessed demonstrate that 14% of European butterflies and 9% of European wild bees are threatened of extinction, but data about trends are scarce. To fill this gap concretely, the availability of a representative, permanent monitoring network will be crucial to collect semi-quantitative data to plan and evaluate conservation actions. To date, only butterflies, among invertebrates, are monitored at EU level under a shared network. Butterflies are taxonomically well-known and many of them are reasonably easy to identify in nature, a fact that has stimulated thousands of enthusiastic citizens to cooperate in recording observations of their occurrence. Such CS activities are run under the coordination by the European Butterfly Monitoring Schemes (eBMS). Available data show a continuous decline in abundance almost in each country included recent data from north America. Pressures and threats acting on pollinators include pesticides, intensification and abandonment of agriculture and traditional pastures as well as air and light pollution.

Centuries of botanicals in arthropod pest control, but something is still missing

Priscilla Farina[1*]
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Botanical pesticides, derived from plant tissues variously extracted or distilled, are certainly not a recent discovery. Indeed, for centuries they have been part of the arsenal available to humans to defend themselves and their animals and crops against insect and mite pests. Their use began to decline around the 1940s, when they were replaced by synthetic pesticides, which are undoubtedly effective but, concurrently, more toxic to the non-target species, pollutant for the soil, groundwater, and air, and cause of the development of resistance when misused. What we are now experiencing is a renewed interest in botanicals as a possible greener, eco-friendly, and sustainable alternative to most of the pesticides of chemical origin. Currently, azadirachtin, pyrethrum (both of which are broad-spectrum insecticides and repellents), and some plant primary metabolites (such as formic and oxalic acids used as miticides in beekeeping) account for the largest share of the botanical pesticide market. An outstanding potential in arthropod pest management has also been shown by the essential oils, although their applications in the field and under operational conditions are currently limited. Essential oils are heterogeneous mixtures of secondary metabolites obtained from aromatic plants and are valued for their low toxicity to vertebrates, high biodegradability, and multiple modes of action that likely avoid the development of resistance. However, what is still missing are proper chemical characterizations (some plant species show chemotypes with different compositions), sensory evaluations (essential oils have specific odours and flavours that should be matched with the intended applications like as environmental sprays, skin treatments, or food protectants), and formulations within stabilising matrices (e.g., chitosan, cellulose, exopolysaccharides) or through micro- and nano-technologies (e.g., encapsulation, sonication). To cope with such shortcomings, a joint effort by entomologists, chemists, producers, sensory analysts, food technologists, engineers, and many other professionals is needed as soon as possible.

Modeling and forecasting landslides occurrence at regional/national scale

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A "landslide" refers to the downward movement of a mass of rock, debris, or soil along a slope under the influence of gravity. These events can be triggered by various factors, including intense or prolonged rainfall, earthquakes, rapid snowmelt, and human activities. Landslides can be classified in several ways, depending on the type of movement involved. The most common types in Italy include flows, slides, falls, and topples, with many landslides exhibiting a combination of these movements.
The prediction of landslide occurrences and their spatial and temporal impacts remains an ongoing scientific challenge.
From a land-use planning perspective, the creation of susceptibility maps—representing the spatial probability of landslides—is essential. For emergency management, accurately forecasting the occurrence of landslides in the short term is critical. Both aspects are crucial for the development of geographical and territorial early-warning systems.
The presentation will focus on discussing various modeling techniques and prediction approaches related to large-scale landslide occurrences, as developed by the author and their research team.
Additionally, different methods and approaches for assessing susceptibility to various types of landslides will be discussed, along with the activities involved in the development, implementation, and operational use of systems designed for forecasting rainfall-induced landslides.

Climate change and the carbon cycle: implications for agriculture and forest ecosystems

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Earth is warming at an unprecedented rate and the effects of such warming are becoming more and more evident everywhere around the world, from the Arctic, to mid-latitudes and to the tropics. There are also natural causes for climate change, but is now universally accepted among scientists (with very few exceptions) that the prevalent origin of climate change is due to human activities, especially fossil fuel burning and land-use change, causing the increase in greenhouse gas concentration in the atmosphere. The increase in global mean temperature has reached 1.2°C, but in some regions, like the Arctic and the Mediterranean, much higher increases are evident. On top of these changes there are many climatic feedbacks which can cause serious consequences, reaching tipping point for the climate system. Human activities are causing huge increase of CO_2 concentration in the atmosphere and altering the carbon cycle. Only a fraction of CO_2 emissions remains in the atmosphere, while about half is taken up by land biosphere or absorbed by oceans.
Using different concentration and isotope approaches it is possible study sources and sinks for carbon dioxide and to study the global carbon cycle. The importance of land biosphere and nature based solutions (NBS), crop and forest interplay will be discussed.

Non-coding RNAs in Environmental Stress Responses

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Genomic DNA serves as the template for RNA synthesis by DNA dependent RNA polymerases. Although many RNAs guide protein synthesis, a substantial subset, the non coding RNAs (ncRNAs), are essential regulators of gene expression at the epigenetic, transcriptional, and post transcriptional levels. The latter encompasses miRNAs (miRNAs), small interfering RNAs (siRNAs), and long non-coding RNAs (lncRNAs), among many other types.

In plants, ncRNAs function as essential regulators of transcriptional activity, modulating a wide range of developmental processes such as the formation of roots, leaves, flowers, endosperm, and seeds—and thereby playing a central role in guiding proper developmental outcomes throughout the plant life cycle. They also have been recognized as key modulators of environmental stress responses through the fine-tuning of stress-responsive gene networks, by regulating signaling pathways, hormonal responses, and metabolic adjustments.

In this presentation, we will explore how ncRNAs contribute to the adaptive responses of plants under various stress conditions. A deeper understanding of the pivotal roles ncRNAs play in plant stress responses provides valuable insights into the mechanisms that underpin plant resilience. Moreover, this knowledge opens new avenues for developing innovative strategies to enhance crop stress tolerance.

Role of ion channels in cancer

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Classically, the functions of ion channels have been studied in the context of rapid transmission of electrical signals in neurons and muscle cells. Yet, ion channels participate in virtually all processes a cell–electrically excitable or not– performs, both in physiological and pathological conditions. Cancer is not an exception to this rule, and ion homeostasis, controlled by ion channels and transporters, plays essential roles in tumor initiation, survival, crosstalk with the microenvironment, immunological escape, local spread, and metastasis. In some cases, the function and distribution of the channels in cancer cells are indistinguishable from normal cells; in other cases, the tumor cell hijacks the properties of ion channels and uses them to its advantage. Ion channels are among the most frequent targets for natural and synthetic medicinal products because they are typically accessible, small quantitative changes lead to large effects, and these can be quantified and characterized with much more precision than in other protein families. Combined with a better understanding of their role in cancers, their pharmacological properties have opened a promising window for intervention–using newly designed or repurposed drugs– that is only starting to be exploited. We will review our current understanding of some crucial roles of ions during cancer progression and give some examples of how this can be modified to improve the disease outcome.

Animals as sentinels for environmental health: the role of veterinary oncology

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Domestic animals share the same environment with human beings, and some of the diseases that are described in domestic animals have a homologous human counterpart; thus, veterinary medicine, and especially veterinary oncology, could represent a comparative spontaneous model for some environment-associated human diseases.

Leveraging Satellite Data and Machine Learning for Agricultural and Environmental Insights

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Freely available satellite data, such as that obtained by the Sentinel-2 mission, can prove to be an invaluable tool for agriculture and ecological science. With its multispectral instrument, Sentinel-2 produces data with up to 10-meter resolution every 5 days, from 2017 to the present date, on almost every part of the globe. This time-series dataset is used to obtain satellite images and vegetation indices such as NDVI and EVI, enabling real-time monitoring of crops, forests, or any other area of interest. Even though the monitoring of an area of interest is valuable by itself, the integration of these datasets with machine learning algorithms allows an entirely new range of possibilities. Applications include crop yield prediction, vegetative biomass estimation, land use and land cover classification, and many more. These developments highlight the great potential of combining satellite data with machine learning algorithms to enhance agricultural and ecological research.

Artificial Intelligence in Livestock Farming

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Artificial Intelligence (AI) is revolutionizing livestock farming, offering advanced tools to improve efficiency, animal welfare, and environmental sustainability. Current technologies make it possible to collect data from sensors and integrate them into predictive models, but the real step forward will be the adoption of deep learning, which can detect complex patterns through deep neural networks. AI enables, for example, the optimization of feeding strategies, reduction of waste, prediction of health issues, and more efficient management of farm resources and processes. However, these benefits depend on data quality, the availability of specialized skills, and the continuous evolution of technology.

The adoption of AI also raises critical issues: the risk of human intuition being overtaken by automated systems, the difficulties of access in less developed countries, and the concentration of technological power in a few global companies. Moreover, the lack of transparency in machine decision-making processes calls for ethical reflection on the role of humans in the control of technology.

To effectively integrate AI into livestock farming, it will therefore be essential to ensure proper governance, ongoing training, and attention to ethical aspects, in order to guarantee a sustainable and responsible evolution of the sector.

Genome editing confers disease resistance in grapevine for a healthier agriculture

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Grapevine (*Vitis vinifera* L.), is one of the oldest and most cultivated perennial non-climacteric fruit crops in the world. It is also a scientifically attractive crop for several aspects such as the high quality of its reference genome sequence, its high heterozygosity which allows allele/haplotype specific analyses and the presence of many valuable resources such as detailed transcriptomic datasets. However, it is generally recalcitrant to transformation and regeneration, and the application of the New Breeding Techniques is highly impaired by this limitation. Recently, an efficient protocol for the induction of embryogenic callus, the isolation of protoplasts, and the
regeneration of whole grapevine plants has been setup in different Italian and international grapevine cultivars. Moreover, it was demonstrated the possibility to obtain a transgene-free edited grapevine by the direct delivery of Cas9/sgRNA RNP complexes into protoplasts and subsequent regeneration.
Grapevine is facing strong pest and disease pressures. Downy mildew (*Plasmopara viticola*), powdery mildew (*Erysiphe necator*), botrytis (*Botrytis cinerea*) can cause major damage impacting the qualitative and quantitative characteristics of grapevine production. Grapes receive about two-thirds of the fungicides used in the EU, despite covering only ~3.5% of the agricultural area. For that reason viticulture is not sustainable to date. The possibility to apply genome editing via the CRISPR/Cas9 system and produce DNA-free genetically resistant grapes, presents a promising avenue for the development of tools suitable to mitigate the current viticulture challenges, including fungal diseases, helping to address the regulatory concerns related to genetically modified plants.

Wastewater reuse: balancing sustainability and human health risks

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The reuse of treated wastewater is increasingly recognized as a sustainable solution to water scarcity and climate adaptation, in line with Goal 6 (Clean Water and Sanitation) and Goal 13 (Climate Action) of the 2030 Agenda for Sustainable Development. By reducing dependence on freshwater sources, wastewater reuse can support agriculture, industry, and urban ecosystems. However, this potential must be weighed against critical public health concerns.

When inadequately treated, reclaimed water can become a vehicle for waterborne pathogens, including bacteria (e.g., enteropathogenic *Escherichia coli*, *Salmonella* spp.), viruses (e.g., norovirus, hepatitis A virus), and parasites (e.g., *Giardia*, *Cryptosporidium*). These pathogens are typically associated with fecal contamination and can lead to gastrointestinal illnesses, especially when water is used for irrigating food crops consumed raw or for recreational purposes. The oral-fecal transmission route is a key concern in low- as well as in high-income countries, particularly for vulnerable populations such as children, the elderly, or immunocompromised individuals.

To mitigate the potential health and environmental risks associated with the reuse of treated wastewater, the European Union introduced Regulation (EU) 2020/741, which establishes minimum quality requirements specifically aimed at agricultural irrigation. This regulation defines chemical and microbiological standards (e.g., biochemical oxygen demand, total suspended solids, *E. coli*) to ensure the safety of crops and protect public health. In addition, the regulation mandates the implementation of a comprehensive risk management approach based on the World Health Organization's Water Safety Plan framework and includes risk identification, monitoring, mitigation strategies, and continuous verification to ensure compliance and safety.

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