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Lectures

Selected Lectures of the Meeting "Autism and the code of omics sciences"

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The Meeting "Autism and the code of omics sciences" is a Satellite Meeting of the 21st International Workshop on Neonatology and Pediatrics, Cagliari (Italy), October 22nd-25th, 2025.

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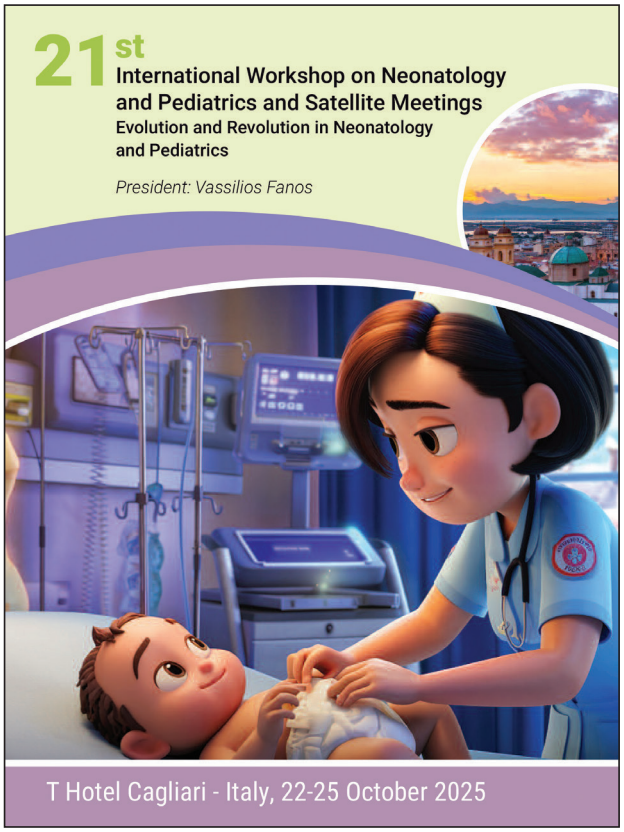

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LECT 1

CRACKING THE METABOLIC CODE: METABOLOMICS AS THE KEY TO INTERPRETATION

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Metabolomics has emerged in recent years as a key discipline in the life sciences, enabling the comprehensive exploration of the universe of metabolites that constitute an organism's biochemical signature. Through high-resolution techniques such as mass spectrometry and nuclear magnetic resonance, metabolomics provides a detailed profile of small molecules involved in key cellular processes. This discipline enables a dynamic, real-time representation of the physiological state, providing a unique tool for understanding the simultaneous impact of genetic, environmental, dietary, and behavioral factors.

Deciphering the "metabolic code" involves interpreting the complex signals that regulate health and disease, as well as identifying early biomarkers and critical metabolic pathways. This perspective has already demonstrated enormous potential in various fields, including the early diagnosis of diabetes and cardiovascular disease, the monitoring of neurological and oncological disorders, and the understanding of the role of the gut microbiota in regulating systemic metabolism. The integration of metabolomics with other "omics" sciences – genomics, transcriptomics, and proteomics – also paves the way for a systemic and multilevel view of human biology, capable of generating more comprehensive and innovative knowledge.

From this perspective, metabolomics is not merely a descriptive tool but a valid key to understanding biological complexity. Its application promises to revolutionize precision medicine, enabling increasingly targeted and personalized prevention and treatment strategies, with the ultimate goal of improving people's quality of life and life expectancy.

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LECT 2

NEW FRONTIERS OF PRECISION MEDICINE IN PEDIATRIC HEALTH: NUTRIMETABOLOMICS

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Precision medicine represents a radical paradigm shift in the biomedical field. The traditional approach, which is based on standardized therapeutic protocols

for the average patient, is evolving towards a model that integrates omics sciences with environmental, behavioral, and nutritional determinants. This integration aims to outline truly personalized diagnostic, therapeutic and preventive strategies. This development is attributable to substantial progress in the domains of high-throughput instrumental analysis and biocomputing [1, 2]. This assertion is further substantiated by significant scientific evidence that underscores the pivotal role of lifestyle, particularly nutrition, in determining health, particularly during the early stages of development [3]. Indeed, genetics accounts for approximately 30% of health outcomes, while individual medical history contributes about 10%, leaving a substantial margin of influence attributable to environmental, behavioral, and nutritional factors [1]. For this reason, among the various omics sciences, metabolomics is rapidly establishing itself as an innovative and effective analytical tool. It enables the immediate identification of metabolic alterations resulting from the interaction between specific pathophysiological states, gene expression, the environment, and diet [3]. This novel approach is particularly pertinent in the domains of neonatology and pediatrics, as nutritional intake during the early stages of life plays a critical role in metabolic programming and, consequently, the long-term health of the individual. In the interest of prevention, the objective is to identify early metabolic profiles associated with the development of diseases [3]. From a diagnostic perspective, the aim is to select reliable biomarkers of adherence to healthy eating habits [4]. These are some of the applications of nutrimetabolomics, which is emerging as an innovative tool with the aim of shifting the science of nutrition from a descriptive discipline to a quantitative and predictive science, through the precise measurement of metabolites associated with specific nutrients or dietary patterns, capable of measuring the personal response to a dietary intervention [2-4].

However, the full potential of nutrimetabolomics has yet to be realized, primarily due to the absence of consensus on methodological standards, significant heterogeneity in analytical and bioinformatic protocols and the paucity of comprehensive reference databases [2, 3].

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LECT 3

FOODOMICS: THE HIDDEN LANGUAGE OF FOOD FOR OUR HEALTH

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Foodomics is an emerging interdisciplinary field that combines advanced omics technologies, such as genomics, transcriptomics, proteomics, metabolomics and microbiomics, with nutritional science to understand how food and its components can influence human physiology at a systemic level. This approach views food not merely as a source of energy or nutrients, but as a complex reservoir of biochemical signals capable of modulating key biological pathways involved in health, disease prevention, and even emotional regulation.

Several bioactive components, including tryptophan, tyrosine, omega-3 fatty acids, polyphenols, and prebiotic fibers, have been demonstrated to influence neurochemical activity, immune response, and systemic inflammation. These effects are mediated in part by the gut-brain axis, a bidirectional communication system linking the gut microbiota, intestinal barrier, immune system, and central nervous system [1, 2]. Understanding this intricate crosstalk is crucial for elucidating how specific foods or dietary patterns may contribute to emotional regulation, stress resilience, and overall mental well-being.

Foodomics enables the investigation of these mechanisms by integrating analytical platforms such as nuclear magnetic resonance spectroscopy and mass spectrometry with multivariate data analysis. These technologies enable the identification of metabolic signatures associated with nutritional interventions, providing insight into the molecular effects of individual nutrients and whole diets. In particular, metabolomic profiling has proven effective in detecting shifts in biochemical pathways related to neurotransmission, oxidative stress, and lipid metabolism, all of which are relevant to mental and cognitive health.

Beyond mechanistic insight, foodomics contributes to the evolution of personalized nutrition and precision medicine by supporting the design of evidence-based dietary strategies tailored to individual metabolic phenotypes. By elucidating the molecular interactions between food-derived compounds and biological systems, this approach offers a systems-level framework for nutritional interventions aimed at improving both physical and mental well-being.

Ultimately, foodomics redefines the role of food, from a passive sustenance to an active biological modulator, opening new perspectives for integrative approaches to health promotion and disease prevention, with diet serving as a central tool for maintaining physiological and emotional balance.

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LECT 4

THE "*INSIEME*" PROJECT

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Autism is a complex neuropsychiatric disorder that requires multidisciplinary and personalized therapeutic approaches. This pilot project investigates the potential of metabolomic analysis to improve the understanding and management of autism in children. Through the analysis of urine samples from 100 patients, recruited through 20 associations, the aim is to identify metabolic biomarkers related to autistic phenotypes. The goal is to develop personalized diets based on individual metabolic profiles, evaluating their effectiveness through follow-ups at 6-8 months. Data analysis, supported by artificial intelligence and machine learning techniques, will allow metabolites and symptoms to be correlated. The project involves collaboration with academic institutions to ensure scientific validity.

Expected results include the identification of biomarkers, the creation of personalized dietary guidelines, and raising awareness among families about the importance of nutrition in treating autism. This pilot study represents an innovative step toward a personalized approach to therapy, potentially improving the quality of life of patients.