UNIVERSITÀ DEGLI STUDI DI UDINE
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DIPARTIMENTO
DI SCIENZE AGROALIMENTARI,
AMBIENTALI E ANIMALI

PHD SCHOOL IN AGRICULTURAL
SCIENCE AND BIOTECHNOLOGY

PhD Winter School

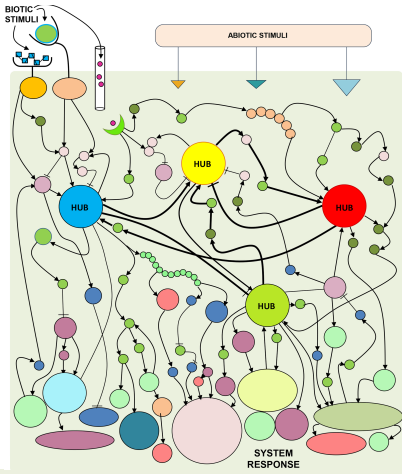
An introduction to Systems Biology

8:45 A brief presentation of the school (prof. Francesco Nazzi, UniUD)

9:00-10:00 **Mathematics as a language to explain mechanisms**
prof. Franco Blanchini, UniUD

10:15-11:45 **Systems Biology: quantitative and qualitative approaches to life sciences**
prof. Giulia Giordano, UniTN

12:00-13:30 **A primer on dynamics for systems biology**
prof. Dimitri Breda, UniUD



Tuesday 16th March 2021
Teams: Ph.D. Winter School

Mathematics as a language to explain mechanisms (prof. F. Blanchini)
Mathematics plays a fundamental role in disciplines such as physics, engineering, computer science, chemistry and it has been more recently accepted as a suitable language for solving problems in biology, biochemistry, medicine. In this talk we discuss the structural analysis of systems, aimed at explaining how mechanisms work, why they work in a certain way and to which extent they perform their task properly even in the presence of perturbations and disturbances. The first part of the talk briefly introduces some preliminary motivating examples of mechanisms, borrowed from several disciplines in a broad sense to explain how math can be the natural language to describe many natural phenomena. The second part discusses application examples from biology and biochemistry, to showcase the potential impact that the mathematical approach, suitably adapted, can have in these disciplines. The main goal of the presentation is to stress how interdisciplinary research can bring interesting tools to people working in biological disciplines as well as fresh ideas to the theoreticians, along with new problems to investigate.

Systems Biology: quantitative and qualitative approaches to life sciences (prof. G. Giordano)
The complexity of systems in the life sciences increasingly requires an interdisciplinary investigation, relying on the joint efforts of biologists, chemists, physicians as well as mathematicians, physicists, computer scientists and engineers. A quantitative and model-based study of biological systems is facilitated by the progress of omic- technologies (genomics, proteomics), which makes huge amounts of data available. In this context, systems biology has emerged as a strong network of disciplines concerned with the integrated, holistic study of the interactions between the components of biological systems, and of how these interactions give rise to the overall function and behaviour: systems biology aims at understanding the design principles of life with system-theoretic tools and techniques. We provide an overview of systems biology, illustrating some quantitative and qualitative approaches to the life sciences. In particular, we discuss examples of biomolecular systems and their fundamental robustness properties, with a case study related to intracellular ceramide transport in mammalian cells.

A primer on dynamics for systems biology (prof. Breda)
The dynamical analysis of mathematical models is often a key step in understanding the behavior of systems. Even in the presence of a certain degree of complexity, foundational concepts and principles like those of equilibria, their stability, the process of linearization and the emergence of bifurcations under varying or uncertain parameters maintain their validity unaltered. In this practical activity, by way of simple examples, we review the basic mathematical tools required to tackle such an essential analysis, aiming at grasping the deep significance of the aforementioned notions. Hints on relevant software tools will be given to complete this concise overview.