

## PROGRAMME

### Monday, September 3

14.00 - 14.30 Registration

14.30 - 16.15 Introduction to the School (R. Musetti, F. Nazzi, M. Spanghero)

16.30 - 18.00 A Statistical Physics Approach to System Biology (S. Suweis)

### Tuesday, September 4

9.00 - 10.30 A Case Study: Emergent Patterns in Mutualistic Ecological Networks (S. Suweis)

11.00 - 12.45 The Use of Systems Biology Approaches in Nutrition and Animal Health Science (Q. Zebeli)

14.30 - 16.00 Metagenomic Techniques Used to Study Gut Microbiome: Case Studies (B. Metzler Zebeli)

16.30 - 18.00 Case Studies Research in Animals (B. Metzler Zebeli)

### Wednesday, September 5

9.00 - 10.30 Analytical Approaches and Numerical Simulations in Modelling Population Dynamics (S. Suweis)

11.00 - 13.00 Introduction to Biological Networks (A. Mahfouz)

### Thursday, September 6

9.00 - 10.30 Root Systems Biology: Getting Beyond a Single Scale (W. Busch)

11.00 - 13.00 Systems Genetics in the Brain (A. Mahfouz)

14.30 - 16.00 How Systems Genetics Uncovers Fundamental Principles of Root Growth Regulation (W. Busch)

16.30 - 18.00 Biological Network Analysis (A. Mahfouz)

### Friday, September 7

9.00 - 10.30 A Practical Session on Network Based Interpretation of Genome Wide Association Studies (W. Busch)

11.00 - 13.00 Round Table and Conclusions (G. Cipriani, G. Firrao)

## ADMISSION AND ACCOMMODATION

The course is mainly addressed to doctoral students on first come first served basis.

The registration fee is 300,00 Euro + VAT taxes\*, where applicable (bank charges are not included).

The registration fee includes a complimentary bag, three fixed menu buffet lunches, coffee breaks, downloadable lecture notes and wi-fi internet access.

Applicants to the course must apply by August 31, 2018. Applications should be made on-line through our web site: <http://www.cism.it/courses/E1803/>.

A message of confirmation will be sent to accepted participants.

Information about travel and accommodation is available on our web site, or can be mailed upon request.

A limited number of rooms is available at our Guest House at the rate of Euro 30,00 per person/night.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email) no later than two weeks prior to the start of the course.

If cancellation occurs less than two weeks prior to the start of the course, a Euro 50,00 handling fee will be charged. Incorrect payments are subject to Euro 50,00 handling fee.

\* Italian VAT is 22%.

For further information please contact:

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33100 Udine (Italy)

ACADEMIC YEAR  
2018

University of Udine  
International Centre for Mechanical Sciences



UNIVERSITÀ  
DEGLI STUDI  
DI UDINE



Centro Internazionale  
di Scienze Meccaniche  
International Centre  
for Mechanical Sciences

## SYSTEMS BIOLOGY

CISM-UniUD Joint course  
coordinated by

PhD School in  
Agricultural Science and Biotechnology  
of the University of Udine

Udine September 3 - 7 2018

## SYSTEMS BIOLOGY

Systems biology deals with the interdisciplinary study of complex biological systems and exploits a holistic approach to unravel the network of interactions connecting the components of those systems, being them genes in a transcriptome, cells of an organism or members of a microbiota.

This introductory course will provide a general overview of the approach, and the analytical methods that are commonly used in this field.

During the week, five leading scientists in the study of cellular interactions, population dynamics, and the biome, will explain the significance of systems biology in their field, will discuss case studies, and will provide the attendees with practical example on how to test the methods they have just learnt.

At the end of the course, participants should be able to:

- see with new eyes the biological problems they normally deal with;
- understand the methods applied to the study of these problems;
- grasp the content of the primary literature dealing with this subject, in order to find inspiration for their work;
- profitably interact with mathematicians and modelers working in this field;
- begin working in the field, if they wish.

The course is organized by the PhD school in Agricultural Science and Biotechnology of the University of Udine, Department of Agricultural, Food, Environmental and Animal Sciences (DI4A).

### Organizing Committee

**Guido Cipriani**, Associate professor – DI4A, UNIUD

**Giuseppe Firrao**, Full professor – DI4A, UNIUD

**Rita Musetti**, Associate professor – DI4A, UNIUD

**Francesco Nazzi**, Associate professor – DI4A, UNIUD

**Mauro Spanghero**, Full professor – DI4A, UNIUD

## TOPICS

### The Physics of Living Systems

Understanding a living system is a formidable many-body problem and the study of living systems represents a fantastic challenge for physicists. In the last decades scientists have unveiled several macroscopic patterns, emerging from ecological and biological systems self-organization, that show a surprising simplicity reminiscent and that may represent a signature of the “universality” of the processes

underlying biological evolution. Indeed, physics is providing powerful theoretical tools and incentivizing innovative steps towards the comprehension and the synthesis of broad empirical evidences of patterns on both spatial and temporal scale in biological systems. In my lectures I will present a physicist view of system biology (and ecology), focusing on some real case examples and showing the key ingredients one needs to incorporate in models so to reproduce the known emergent patterns.

**Samir Suweis** earned a doctorate in Environmental Engineering at the Ecole École Polytechnique Fédérale de Lausanne in 2011. After a visiting period as a researcher at the University of Princeton (NJ, USA), since 2012 he works in the Laboratory of Interdisciplinary Physics at the Physics and Astronomy department, University of Padua, where he holds the position of research scientist (RTDa). His research work is at the interface between ecology, environmental science and biology using theoretical framework provided by the physics of complex systems

### Algorithms for Biological Networks

Molecular biology is concerned with the study of the presence of and interactions between molecules, at the cellular and sub-cellular level. In bioinformatics and systems biology, algorithms and tools are developed to model these interactions, often as networks or graphs, to derive biological knowledge. Professor Mahfouz will give an overview of biological networks and their properties, how to construct them from high-throughput measurements, and how to mine networks for biological knowledge. Next, Professor Mahfouz will summarize the role of systems biology and gene networks in improving our understanding of brain function and disease. We will have a hands-on practical session to try out some network analysis tools.

**Ahmed Mahfouz** is an Assistant Professor in the Computational Biology Center at Leiden University Medical Center in Leiden, The Netherlands and a guest researcher at the Brain and Mind Research Institute at Weill Cornell Medicine in New York. Ahmed's work focuses on understanding the molecular basis of brain function and diseases through network and machine learning approaches.

### From Systems Biology to Systems Genetics of Root Growth

The Arabidopsis root has been at the forefront of plant systems biology for more than a decade. Functional genomics at the cell-type scale has enabled understanding how gene networks are dynamically orchestrated during development and stress response in a complex organ. Professor Busch will outline fundamentals, findings and applications of root systems biology and the emerging area of root systems genetics, as well as host a practical session with hands on training on a relevant approach.

**Wolfgang Busch** is Associate Professor in the Plant Molecular and Cellular Biology and Laboratory, as well as the Integrative Biology Laboratory at the Salk Institute for Biological Studies in La Jolla, California. Dr. Busch's work focuses on understanding which genes, genetic networks, and molecular processes determine root phenotypes. For this, his laboratory exploits natural genetic variation and uses a systems genetics approach that combines large-scale phenotyping, genome wide association studies, genetics, and genomics to find and characterize genes, their alleles, and the genetic networks that ultimately determine root growth.

### The Use of Systems Biology Approaches in Nutrition and Animal Health Science

Prof Zebeli will give an overview of the system biology approaches used in animal sciences. The focus will especially be on the use of transcriptomics, proteomics and metabolomics approaches in cattle research. The introduction of the system biology a few decades ago has revolutionized animal sciences and health. Instead of the old paradigm "one parameter one disease", systems biology provides a much deeper view of the interactions occurring in the body, advancing our knowledge in understanding processes that before were unreachable, and also prevent and treat animals more efficaciously.

**Qendrim Zebeli** is professor of Animal Nutrition at the University of Veterinary Medicine Vienna. Prof Zebeli has a strong interests in using systems biology approaches to elucidate the role of nutrition on animal health and smart prevention.

### Metagenomic Techniques Used to Study Gut Microbiome: Case Studies

The microbiome research of the last years has revealed that microbes can beneficially affect the host but also still there are challenges especially in properly using the bioinformatic information generated to advance the current knowledge. Dr. Metzler-Zebeli will provide details of her research and methods used for studying the gut microbiome both at phylogenetical and functional level. She will also show examples from her research how the diet affects the microbiome and also discuss pitfalls in data mining and coordination.

**Barbara Metzler-Zebeli** is a senior Lecturer at the University of Veterinary Medicine Vienna. Barbara has a strong international reputation in studying gut microbiome of animals using various OMICS technologies and data-processing tools.