Workshop. Systems biology in medicine

Abstract

Systems biology (SB) is a growing area that aims to understand biological systems at a holistic level. SB integrates theoretical and experimental research. SB has applications in various areas related to medicine. However little is known in the medical profession about the theories and techniques behind SB. This workshop is oriented to establish a permanent link between medical doctors and SB scientists fruitful for both fields.

Scientific summary

Contemporary molecular and cellular biology are increasingly becoming quantitative sciences. With the completion of the human genome project, a complete (or nearly) complete “parts list” is available and ready to use by skillful researchers. However the sheer number of cellular components emphasizes the need to understand cells and tissues not as a group of genes, proteins and metabolites, but instead as complex systems. It is impossible to manage large components and intricate interactions with intuition only. Biologists now require quantitative tools widely used in other areas of science such as mathematics and physics. The response is systems biology.

Systems biology (SB) is a growing area that aims to understand biological systems at a holistic level. SB integrates theoretical and experimental research. From the theoretical branch takes methods to study the structure, dynamics and control devices present in life organisms. In particular SB is interested in the topology and behavior over time of biological networks. From the experimental branch SB uses tools that permit the measure of genes, proteins and metabolites at a large scale. For SB genomics, transcriptomics and proteomics are its principal source of data.

As an interdisciplinary field SB tries to take advantage of mathematical, biological, chemical and physical knowledge in order to discover new predictions that can be tested in the laboratory. In the same way, based in data produced by “omics” experiments SB scientists develop new tools that tackle the complexity inherent to biological systems. In practice SB involves an iterative cycle of mathematical modeling, computational simulations, large scale experimental procedures and data evaluation to describe quantitatively a cellular process. Used appropriately, SB methods can represent cellular components and interactions in a physically and biologically realistic manner, incorporate a wide variety of empirical observations, and generate novel and useful hypotheses.

The interest that leading universities, governmental agencies and pharmaceutical industry have in SB is rooted in the fact that computational simulation integrated with experimental data will change the way how we

understand biological systems in health and disease. But to realize this promise it is essential to foster a critical mass of scientists that feel comfortable working in the frontier of biology, physics and mathematics.

SB has applications in various areas related to medicine that range from pathological mechanisms to therapeutical strategies. However little is know in the medical profession about the theories and techniques behind SB. We believe that is necessary to inform physicians about the great potential that SB represents for better patient care. This workshop is oriented to establish a permanent link between medical doctors and SB scientists fruitful for both fields but more important fruitful for patients.

The workshop is organized in one tutorial and two modules. The tutorials cover basic biological and mathematical concepts important for SB. The modules are oriented to describe the relation between basic science and patient care and the role that SB has in translational research.

The workshop is aimed to introduce researchers from the biomedical field interested in being introduced in SB. The workshop will cover the scientific foundations and will explore the opportunities for biomedical research with a strong focus in translational research. Researchers with a background in physics, mathematics and computation are also welcome since they will learn more about biomedical problems and how to use SB for improving health.

Workshop
Systems biology in medicine
Barcelona, May 8-10th 2008

Organizers
Pablo Villoslada. Center for Applied Medical Research. University of Navarra, Pamplona, Spain
Josep Roca. Hospital Clinic - IDIBAPS, Barcelona, Spain
Marta Cascante, Institut de Biomedicina-Universitat de Barcelona (IBUB), Spain
Ricard Sole, University Pompeu Fabra, Barcelona, Spain
Jordi Garcia-Ojalvo. Technical University of Catalonia, Barcelona. Spain

Support team
Ivan Martinez. Department of Neuroscience. Center for Applied Medical Research. University of Navarra, Spain.

Venue: Hospital Clinic of Barcelona – University of Barcelona.

Guest Speakers:
Nicholas Luscombe, European Bioinformatic Institute, Cambridge, UK
Frank Bruggeman. Netherlands Institute for Systems Biology, Amsterdam, NL
Alfonso Martinez Arias. University of Cambridge, UK
Stefan Bornholdt. University of Bremen. Germany
Olaf Wolkenhauer. University of Rostock. Germany
Igor Goryanin. Centre for Systems Biology at Edinburgh. University of Edimburgh. UK
Joan Rodes. Hospital Clinic – IDIBAPS, Barcelona, Spain
Silvia Barcelo. Hospital Clinic – IDIBAPS, Barcelona, Spain
Fernando Corrales. Proteomics center. Center for Applied medical Research, Pamplona, Spain
Luis Mateus Rocha, Instituto Gulbenkian de Ciência, Oeiras, Portugal & School of Informatics and Cognitive Science Program, Indiana University

Language: *English*
Addressed to researchers in the Biomedical field: Medical Doctors, biomedical researchers including PhD students as well as more advanced researchers from Biology, Physics, Mathematics, Engineering and Computational Sciences interested in applying systems biology for biomedical research. A previous training in systems biology or computational biology is not required.

Contents

Introduction to System Biology

Systems Biology in Medicine

Program

Day 1 (8/5/08)		
Morning session	***Foundations of systems biology***	
9:00 – 9:30	Welcome: description of the workshop objectives and activities	Joan Rodes
9:30 – 10:30	Dynamical systems theory	Jordi García-Ojalvo
10:30 – 11:00	Coffee-break	
11:00 – 12:00	Complex Systems	Ricard Sole
12:00 – 13:00	Eukaryotic Systems Biology: network approaches to predict and to explain	Frank Bruggeman
13:00 – 13:30	Lunch	
Afternoon session	***Applications of SB: Fundamental Biology***	
13:30 – 14:30	Biological networks: their structure, function and evolution	Ricard Sole
14:30 – 15:30	Metabolic fluxes	Frank Bruggeman
15:30 – 16:00	Coffee break	
16:00 – 17:00	Systems immunology	Ivan Martinez
17:00 – 18:00	System Biology and Innovation in Biomedicine: towards a new paradigm	Joan Bigorra

Day 2 (9/5/08)		
Morning session	***Applications of SB: Fundamental physiology***	
9:00 – 10:00	Unravelling neurological diseases with systems biology	Pablo Villoslada
10:00 – 11:00	Systems Biology and it's usage for drug R&D	Igor Goryanin
11:00 – 11:30	Coffee-break	
11:30 – 12:30	Biomarkers discovery for stratified medicine	Fernando Corrales
12:30 – 13:30	Signaling pathways and information processing	Alfonso Martinez-Arias
13:30 – 14:30	Lunch & Poster session	
Afternoon session	***Pathophysiology of diseases***	
14:30 – 15:30	Cancer: Multiple perturbations on cancer cell metabolic pathways as new targets for novel designed therapies.	Marta Cascante
15:30 – 16:30	Boolean networks as predictive models for biochemical networks: Chances and Limitations	Stefan Bornholdt

16:30 – 17:00	Coffee-break	
17:00 – 18:00	Chronic respiratory diseases	Josep Roca
18:00 – 19:00	Proteomics in obesity research	Silvia Barcelo

Day 3 (10/5/08)		
Morning session	***Invited lectures***	
9:00 – 10:00	A genomic analysis of transcriptional regulation of the human genome.	Nicholas Luscombe
10:00 – 11:00	The role of modelling in hypothesis-driven systems biology – why there is even in medicine nothing more practical than a good theory	Olaf Wolkenhauer
11:00 – 11:30	Coffee-break	
11:30 – 12:30	Promoting, maintaining and filtering noise during embryonic development	Alfonso Martinez-Arias
12:30 – 13:30	Complex Networks and Bibliome Informatics: applications to computational biology	Luis Rocha
13:30	Lunch and Farewell	

NB: the course include a printed material and auto-questionnaire and a CD with the presentations, web links and free available software