Short PhD Course on Systems Biology

June 6-8 2005
Center for Microbial Biotechnology
And
Center for Biological Sequence Analysis
Technical University of Denmark
Lyngby, Denmark

Course Objectives

Systems biology is the integration of experimental and computational approaches in achieving its overall goal of explaining and predicting complex cellular behaviours of biological systems. It differs from traditional biology approaches in that it aims to study the entire network of interactions between system components rather than the properties of the individual components themselves. Using different -omics technologies a wealth of experimental data is becoming available at many different cellular levels including to some extent the interaction between many of these components. Analysis and integration of such data will greatly benefit from the use of mathematical models – cellular models are therefore at the core of systems biology.

The aim of this short course is to give an introduction to systems biology, to illustrate different approaches to model by driven data analysis and to illustrate how genome-scale metabolic models can be used to simulate cellular behaviour.

Course Content

The course will consist of the following elements:
- An introduction to systems biology
- Reconstruction of genome-scale metabolic models
- Constraints-based modelling: basics and capabilities
- Genome-wide transcription analysis
- Metabolomics: Experimental and data analysis
- Temporal protein-protein interaction networks
- Data driven reconstruction of pathways
- Combination of predicted properties with experimental data
- Examples from yeast, *Escherichia coli* and other bacteria

The course will consist of both lectures and computer exercises.
The course will give 2.5 ECTS credits.

Instructors

Professor Bernhard Palsson
Department of Bioengineering, University of California San Diego

Dr. Palsson is a professor of bioengineering at UCSD. For over 20 years he has been developing computational models of cells. His research group has developed a number of genome-scale models of microorganisms that are in use worldwide. He has published over 200 peer reviewed articles, many of which are focused on network reconstruction, the development of *in silico* analysis methods for systems biology, and the experimental validation of genome-scale models.

Professor Søren Brunak
Center for Biological Sequence Analysis, BioCentrum-DTU, Technical University of Denmark

Søren Brunak is professor of bioinformatics at the Technical University of Denmark and center director at the Center for Biological Sequence Analysis. His center has pioneered the use of machine learning techniques, in particular for prediction – at the protein level – of protein localization, secretion pathways, post-translational modification, non-homology based function prediction, and membrane protein topology.   . Within systems biology the group carries out large scale data integration, for example with the aim of modelling temporal aspects of protein-protein interaction networks. One of the focus areas is cell cycle modelling. Søren Brunak has published several books on bioinformatics and more than 120 peer reviewed articles.

Professor Jens Nielsen
Center for Microbial Biotechnology, BioCentrum-DTU, Technical University of Denmark

Dr. Nielsen is a professor of biotechnology at DTU. His research group is active in the field of metabolic engineering and systems biology, and there is focus on the application of mathematical models for data analysis and prediction of phenotypic behaviour. He has published over 200 peer reviewed articles, many of which are focused on integrated analysis of the metabolism in microorganisms.

Course Program

June 6th

09:00-09:30	Introduction and overview of the course	JN
09:30-12:00	Genome scale models 1) Basic concepts in systems biology 2) Reconstruction methods: metabolism, regulation and signalling 3) Chemically/Genetically structured data bases in the form of a stoichiometric matrix	BOP
12:00-13:00	*Lunch*	
13:00-15:00	Genome-scale models, *continued* 4) Constraints based analysis methods 5) Properties of large metabolic networks	BOP
15:00-18:00	Computer exercises	

June 7th

09:00-10:00	Genome-wide transcription analysis	JN
10:00-12:00	Data analysis using clustering methods and integration of omics data through the use of genome-scale models	JN
12:00-13:00	*Lunch*	
13:00-15:00	Computer exercises on clustering	
15:00-18:00	Metabolome and metabolic flux analysis	JN
19:00-	*Course dinner*	

June 8th

09:00-10:00	Integrative systems biology: prediction of gene and protein function and expression pattern	SB
10:00-12:00	Creating temporal protein-protein interaction network by data integration	
12:00-13:00	*Lunch*	
13:00-15:00	Computer exercises on data integration and protein function prediction	
15:00-18:00	Cell cycle modelling	

Venue

The course will be held at the Technical University of Denmark, which is located in Lyngby close to Copenhagen city. The university is easily accessed from downtown Copenhagen (frequent train and bus connection). The organizers may assist with booking of rooms for the course participants at one of the following hotels/hostel:

Lyngby Hostel:
Lyngby-Tårbæk Youth Hostel is located in historic Raadvad, inside the beautiful 'Dyrehaven' woods. The address is: Raadvad 1, 2800 Lyngby, Denmark. Tel: +45 4580 3074. The prize ranges from 160 DKR (inclusive breakfast) in a dormitory, to 225DKR in a 2-Bed room.
The hostel is approximately 4 kilometers from DTU. You can rent bikes for the beautiful ride between the hostel and DTU - or you may prefer to go by public bus. For further information regarding the hostel visit: http://www.lyngbyhostel.dk

Hotel Scandic Eremitage
Hotel Eremitage is surrounded by shopping and relaxation facilities in the centre of Lyngby Storcenter with direct access to shops and banks.
The Address is: Klampenborgvej, Lyngby Storcenter 62
2800 Lyngby, Denmark, Tel: +45 45 88 77 00.
The prize ranges from DKR 975 (single room) to 1175 (double room) inclusive breakfast. The hotel is situated a few minutes from the highway, close to the train station and the trip to DTU is approx.10 minutes by bus. For further information see http://www.scandic-hotels.dk/eremitage

Registration

Registration is done by filling out the enclosed registration form. The course is restricted to 30 participants and course participants will be appointed on a first to-come basis.

The registration fee is 300€, which are to be paid upon acceptance of the registration. The registration fee covers teaching material, lunches during the three days of the course, the course dinner and tuition fee. There is no tuition fee for DTU students or members of DBRA and FOBI research network.

For registration please return the enclosed form **no later than 15 April 2005** to the address below. All applicants will be notified before 4 May 2005 if they have been accepted for the course.

Further information

Course coordinator Anne Vognsen
Technical University of Denmark
Center for Microbial Biotechnology
Building 223, room 216
DK-2800 Lyngby
Tel.: +45 4525 2692
Fax: +45 4588 4148
E-mail: asv@biocentrum.dtu.dk