The complexity of cellular networks

CVBR - Spring and Fall 2010
RN Conference Room 2nd floor
12 PM, 2nd and 4th Tuesdays of each month
http://regan.med.harvard.edu/CVBR-course.php

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I. Course Description

The Complexity of Cellular Networks is an informal course (no credits, no requirements) that offers a broad overview of interdisciplinary research linking statistical physics and molecular biology. It is intended for postdocs, visiting students and interested faculty members of the Center for Vascular Biology Research. There is no prerequisite or formal requirement for attendance, and no prior familiarity with concepts in statistical physics will be assumed.

II. Goals and Learning Outcomes

The overall goal of this course is to open a window into interdisciplinary research at the boundary of statistical physics and molecular biology, biased towards results related to complex networks research. It showcases the types of problems interesting to both physicists and molecular biologists, thus aiming to foster communication and collaboration between researchers from radically different backgrounds. Expected outcomes of the course:

- Basic familiarity and understanding of the main biology-related results in complex networks, along with parallels to similar phenomena in non-biological settings
- Raising awareness of the non-linear nature of genetic regulation, along with tools to model nonlinear aspects
- Opening a dialog about the importance and danger of simplifications inherent as well as necessary for modeling

- Awareness on the part of attending wet-bench biologists of the types of problems that would interest a fellow physicist

III. Required Readings

- None. Reference material specific to each subject will be provided.

IV. Overall Structure of the Course

The course is designed to provide an overview of selected research topics. The typical class session will consist of:

- A 40 minute presentation of the research topic, accompanied by handouts of the presentation citing all relevant reference material, also made available on-line.
- The presentation will be followed by 20 minutes of questions and discussion

V. Course Outline

The course will run in 2 parts with 7 classes each. Topics for each meeting are listed below. **However, circumstances may call for a departure from this schedule. Any changes to the schedule will be made in advance.**

PART 1. Spring 2010

DATE	TOPIC
Mar 23	1. Meet the cellular networks Brief history of networks Structural features of complex networks Biological networks in their context Upcoming topics related to biological network structure
Apr 13	2. Dynamics on complex networks Overview

Selected results relevant to biological networks
Upcoming topics related to dynamics on biological networks

Apr 27 — 3. Modeling transcriptional regulation, one promoter at a time
Statistical mechanics on promoters
Dynamical aspects of transcription
Noise in gene transcription

May 11 — 4. The logic of genetic regulation
Boolean models and beyond
Network motifs in genetic regulatory networks

May 25 — 5. Transcriptional regulation from microarray data
Review of main reverse engineering methods
Highlights of successes
Problems of missing information

Jun 8 — 6. Regulatory models that mimic phenotype and dynamics 1
The choices in modeling
Boolean models: stable steady states and noise

Jun 22 — 7. Regulatory models that mimic phenotype and dynamics 2
Boolean models: stable cycles and noise

PART 2. Fall 2010

DATE — **TOPIC**

Sep 14 — 8. Modeling the full cellular regulatory system 1
Multi-stability of a complex system and cell types
Modularity and hierarchy in the regulatory network

Sep 28 — 9. Modeling the full cellular regulatory system 2

Results in differentiation
Mutations and noise in genetic regulation
Implications for cancer

Oct 12 10. Protein interaction networks

Oct 26 11. Networks in protein folding

Nov 9 12. Metabolic networks

Nov 23 13. Neural networks

Dec 14 14. Physiological signal complexity and disease