UNIVERSITY OF CALIFORNIA SANTA BARBARA
DEPARTMENT OF CHEMICAL ENGINEERING

CHE 154: Engineering Approaches to Systems Biology
Spring Quarter 2004

Lecture: **Tue/Thu 9:30-10:45am Engr-II Room 3301**

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Grading Policy

Class Attendance/Participation	10%
Homework assignments	30%
Course Project/Final Presentation	60%

Course Reading

- A. Asthagari and D. Lauffenburger, "Bioengineering models of cell signaling", *Annu. Rev. Biomed. Eng.*, **2**: 31-53 (2000).
- H. Bolouri and E.H. Davidson, "Modeling transcriptional regulatory networks", *BioEssays*, **24**:1118-1129 (2002).
- J.M. Bower and H. Bolouri (eds.), **Computational Modeling of Genetic and Biochemical Networks (Computational Molecular Biology)**, MIT Press (2001).
- A.M. Campbell and L.J. Heyer, **Discovering Genomics, Proteomics, and Bioinformatics**, CSHL Press (2003).
- H. DeHong, "Modeling and simulation of gene regulatory systems: a literature review", *J. Comp. Biol.*, **9**:67-103 (2002).
- M. Fussenegger, J.E. Bailey, and J. Varner, "A mathematical model of caspase function in apoptosis", *Nat. Biotechnol.*, **18**(7): 768-774 (2000).
- J. Gerhart and M. Kirschner, **Cells, Embryos, and Evolution: Toward a Cellular and Developmental Understanding of Phenotypic Variation and Evolutionary Adaptability**, Blackwell Science (1997).
- D.T. Gillespie, "Exact stochastic simulation of coupled chemical reactions", *J. Phys. Chem.*, **81**:2340-2361 (1977).
- A. Gilman and A. Arkin, "Genetic code: representations and dynamical models of genetic components and networks", *Annu. Rev. Genomics Hum. Genet.*, **3**:341-369 (2002).
- J. Hasty, D. McMillen, F. Isaacs and J.J. Collins, "Computational studies of gene regulatory networks: in numero molecular biology", *Nature Rev. Genetics*, **2**:268-279 (2001).
- J. Hasty, D. McMillen and J.J. Collins, "Engineered gene circuits", *Nature*, **420**:224-230 (2002).
- T. Ideker, T. Galitski, and L. Hood, "A new approach to decoding life: systems biology", *Annu. Rev. Genomics Hum. Genet.*, **2**: 343-372 (2001).
- H. Kitano, **Foundations of Systems Biology**, MIT Press (2001).
- J.-C. Leloup and A. Goldbeter, "Modeling the molecular regulatory mechanism of circadian rhythms in Drosophila", *BioEssays*, **22**: 84-93 (2000).
- H. McAdams and A. Arkin, "Simulation of prokaryotic genetic circuits", *Annu. Rev. Biophys. Biomol. Struct.*, **27**:199-224 (1998).
- H. McAdams and A. Arkin, "Towards a circuit engineering discipline", *Curr. Biol.*, **10**:R318-R320 (2000).
- S. Neves and R. Iyengar, "Modeling of signaling networks", *BioEssays*, **24**:1110-1117 (2002).
- M. Ptashne and A. Gann, **Genes & Signals**, CSHL Press (2002).
- C. Rao and A. Arkin, "Control motifs for intracellular regulatory networks", *Annu. Rev. Biomed. Eng.*, **3**:391-419 (2001).
- C. Rao, J. Kirby, and A. Arkin, "Design and Diversity in Bacterial Chemotaxis: A Comparative Study in Escherichia coli and Bacillus subtilis", *PLoS Biology*, **2**: 239-252 (2004).
- P. Smolen, D.A. Baxter, and J.H. Byrne, "Modeling transcriptional control in gene networks – methods, recent results, and future directions", *Bull. Math. Biol.*, **62**:247-292 (2000).

- J.J. Tyson, A. Csikasz-Nagy, and B. Novak, "The dynamics of cell cycle regulation", *Bioessays*, **24**(12):1095-1109 (2002).
- E.O. Voit, **Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists**, Cambridge University Press (2000).
- T.-M. Yi, Y. Huang, M.I. Simon, and J. Doyle, "Robust perfect adaptation in bacterial chemotaxis through integral feedback control", *PNAS*, **97**:4649-4653 (2000).

Relevant WWW sites

1. http://www.systems-biology.org/
2. http://www.systemsbiology.org/
3. http://csbi.mit.edu/
4. http://www.sbw-sbml.org/
5. http://www.iscb.org/
6. http://molbio.info.nih.gov/molbio/
7. http://www.ecocyc.com
8. http://www.kegg.com

COURSE OUTLINE AND TIMETABLE

Lecture #	Dates	Topics
1	Mar 30	❑ **Course overview and logistics**
2-6	Apr 1 Apr 6 Apr 8 Apr 13 Apr 15	❑ **Overview of cellular regulation** ❑ Central dogma ❑ Genome sequences ❑ Genome expression ❑ Genomic circuits ❑ Protein/Metabolic/Signaling networks ❑ High throughput biological data ❑ Biological databases
7-11	Apr 20 Apr 22 Apr 27 Apr 29 May 4	❑ **Math modeling and systems analysis tools** ❑ Modeling strategies ❑ Boolean models ❑ Nonlinear ODE models ❑ Discrete stochastic models ❑ Systems biology modeling packages ❑ Network analysis – robustness, identifiability ❑ Design of experiment issues
12	May 6	❑ **Project proposals – in-class presentations**
13-14	May 11 May 13	❑ **Case Study: bacterial chemotaxis** ❑ **Case Study: lambda phage**
15-16	May 18 May 20	❑ **Case Study: circadian rhythm**
17-18	May 25 May 27	❑ **Case Study: caspase signaling cascade** ❑ **Case Study: pap pili phase variation**
19	Jun 1	❑ **Summary, review, and trends**
20	Jun 3	❑ **Final project presentations**