

BE777 Syllabus (Fall 2009)

PART 1: Systems Biology of Metabolic Networks (Daniel Segrè)

(Texts: The Regulation of Cellular Systems, Heinrich and Schuster; Metabolic Engineering, Stephanopoulos, Aristidou, Nielsen; Systems Biology, Properties of Reconstructed Networks. Bernhard O. Palsson)

1. The logic of metabolism, major pathways and measurement of metabolic fluxes
2. Kinetic modeling of small metabolic networks
3. Mathematical background: convex analysis, Linear Programming, Quadratic Programming
4. Constrained-based genome-scale models of metabolism: flux balance analysis
5. Elementary Modes, Extreme Pathways
6. Statistical properties of metabolic network topology, network expansion

PART 2: Systems Biology of Transcriptional Networks (Daniel Segrè)

(Text: Uri Alon, An introduction to Systems Biology)

1. Systems biology of transcription network: timescales and basic equations
2. Evolution of regulatory networks and the emergence of network motifs
3. Coherent feed forward loops
4. Incoherent feed forward loops
5. Other network motifs; Convergent evolution of network motifs
6. Natural selection of gene circuits; benefit-cost analysis; optimal design
7. Network motifs in developmental, signal transduction and neuronal nets

Midterm Exam on Parts 1 and 2

PART 3: Molecular Evolution (Brandon Xia)

(Text: Wen-Hsiung Li, Molecular Evolution)

1. Intro to molecular evolution; dynamics of genes in populations
2. Estimating the number of nucleotide substitutions
3. Molecular phylogenetics
4. Rates and patterns of nucleotide substitution; molecular clocks
5. DNA polymorphism in populations
6. Mechanisms of molecular evolution
7. Mechanisms of genome evolution

PART 4: Selected Algorithms in Computational Genomics (Brandon Xia)

(Text: Richard Durbin et al, Biological sequence analysis)

1. Markov Chain Monte Carlo 1: Gibbs sampling
2. Markov Chain Monte Carlo 2: Metropolis sampling
3. Naïve Bayes and linear classifiers
4. Graphical models 1: Hidden Markov models
5. Graphical models 2: Bayesian networks, Markov random fields

Final Exam on Parts 3 and 4