Dynamical Models in Biology

Instructor: Claudio Altafini, SISSA (Int. School for Advanced Studies), Trieste. e-mail: `altafini@sissa.it`

Aim: The course aims at providing an overview of some of the mathematical tools used in the modeling of biological phenomena. The emphasis is on nonlinear models and system analysis, and the examples are mostly from signaling and metabolic pathways.

Topics:

1. Qualitative analysis of ODE models
   - single and two-species dynamics
   - linear and nonlinear systems, equilibria and (multi)stability;
   - phase plane, oscillations;
   - small-scale examples:
     - autoregulatory gene circuits
     - epidemic models (HIV dynamics, kinetic of prion replication)
     - oscillations (Hodgkin-Huxley and Fitzhugh-Nagumo models)
     - adaptation (bacterial chemotaxis, sensory responses).
2. Dynamical theories for biological networks:
   - Stoichiometric network analysis
   - Chemical reaction network theory

References:

- L. Edelstein-Keshet. "Mathematical Models in Biology", SIAM Classics, 2005.
- E. Sontag, "Lecture Notes in Mathematical Biology", available online at the URL: http://www.math.rutgers.edu/∼sontag/613.html
- B. Ingalls, "Mathematical Modeling in Systems Biology: an Introduction", available at the URL: http://www.math.uwaterloo.ca/ bingalls/MMSB/
- U. Alon, "An Introduction to Systems Biology", CRC press, 2007.
- B. O. Palsson, "Systems Biology", Cambridge Univ. Press, 2006.

Time table: Course of $10 \div 12$ lectures (2 two-hours lectures per week): Classes hours: Tuesday and Friday at 9:00, room 132. Starts Nov. 5th.

Course requirements: Basic courses of linear algebra and ODEs.

Examination and grading: final project (report + seminar). I will hand out a list of projects later on.