1: Introduction (1 week):

– Introduction to python language: basic commands.
– Basic data processing in python.

2: Non-extended dynamical systems. Genetic networks (4 weeks)

– Introduction to ODE's. Fixed points and nullclines.
– Slaving and freezing conditions. Applications to cell reactions.
– Stochastic modeling: Random number generator. Application to cell signaling.

3: Spatially extended systems. Pattern formation in biology (4 weeks)

– Introduction to Pattern formation: Linear Stability and Amplitude Equations.
– Reaction-diffusion systems. Morphogenesis and the Turing Mechanism.
– Patterns in the Brain: Neural fields.

4: Modeling processes in networks. Ecology and epidemiology. (3 weeks)

– Introduction to networks and their implementation.
– Logistic map. Presence of chaos and its control.

5: Seminar series on complex modeling (1 week)

– Modeling spatial population genetics (Dr. Simone Pigolotti).
– Modeling self-organization in biology (Dr. Sergio Alonso).
Methodology:

The course will be centered in code-implemention classes and its theoretical and biological interpretation. Six different hands-in will be ordered to extend the codes done in class. Besides the normal classes, a few seminars showing examples of different types of modeling in biology will be given. A personal laptop every two students will be very handy.

Project:

All students should pair to reproduce, understand, explain and work on a biophysical model. A set of different projects with the explanation of the biophysical model to be developed will be listed in Atenea. One of these projects will be assigned to each group according to interests. At the end of the semester, every pair of students will hand a working code and an explanation related with the project. A formal examination of the simulations performed by the group will be held. The possibility to do an extended project with a very strong biological context will be available upon demand.

Project tutors:
Simone Pigolotti, Clara Prats, and Sergio Alonso

Instructors:
Enric Alvarez-Lacalle (coordinator), Romualdo Pastor, and Antonio J. Pons

Exams and grading policy:

The students' evaluation will consist on grading the work done in class and at home through handed-in homework (HE), and the formal evaluation of the project (PE). There will not be a mid-term exam nor a final exam. The final mark will be given by:

$$0.6 \times HE + 0.4 \times PE$$

Bibliography:

Basic:

–Brian P. Ingalls *Mathematical Modeling in Systems Biology*
–A. Barrat, M Barthélemy, A. Vespignani. *Dynamical Processes on Complex Networks*
–J. DiStefano III. *Dynamic System Biology: Modeling and simulation*

Complementary:

–P.D. Murray. *Mathematical biology*
–Y. Vodovotz, and G. An *Systems biology: mathematical modeling and model analysis*