ChE-411

# Principles and applications of systems biology

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| Cursus | Sem. | Type |
|---|---|---|
| Bioengineering | MA3 | Opt. |
| Biotechnology minor | H | Opt. |
| Computational science and Engineering | MA1, MA3 | Opt. |
| Ing.-chim. | MA1, MA3 | Opt. |
| Life Sciences Engineering | MA1, MA3 | Opt. |
| Sciences du vivant | MA3 | Opt. |
| Systems Engineering minor | H | Opt. |

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|---|---|
| Language of teaching | English |
| Credits | 3 |
| Session | Winter |
| Semester | Fall |
| Exam | During the semester |
| Workload | 90h |
| Weeks | 14 |
| **Hours** | **3 weekly** |
| Courses | 2 weekly |
| Exercises | 1 weekly |
| **Number of positions** | |


## Summary

The course introduces key concepts from systems biology and systems engineering methodologies used for the study of complex biological networks. It presents and analyzes the methodologies for the development of models of biological networks.


## Content

The course will include the following topics:

- Methods and technologies for monitoring cell-wide gene expression
- Mathematical and computational analysis of gene expression data
- Methods and technologies for monitoring cell-wide protein expression
- Mathematical and computational analysis of protein expression data
- Methods and technologies for identification of protein-protein interaction
- Mathematical and computational analysis of protein-protein interaction data
- Methods and technologies for identification of DNA-protein interaction
- Mathematical and computational analysis of DNA-protein interaction data
- Genetic networks
- Mathematical methods for the identification of genetic regulatory networks
- Modeling and Simulation of gene expression networks
- Translation networks
- Modeling and Simulation of protein expression networks
- Methods and technologies for monitoring metabolic reaction networks
- Mathematical and computational analysis of metabolic reaction networks
- The course offers computer laboratory.

## Learning Prerequisites

### Recommended courses

Analysis I-III, linear algebra, probability and statistics, physical chemistry.
The building of working groups will make it possible for people with partial knowledge in these fields to contribute depending on their formation.
For SSV students: Dynamical Systems Theory for Engineers or "Mathematical and Computational Models in Biology" course, Felix Naef

### Important concepts to start the course

For the computational exercises, MATLAB® will be used intensively.

## Learning Outcomes

By the end of the course, the student must be able to:

- Formulate mass balances of reaction networks
- Solve mass balance equations using linear programing solvers
- Analyze papers on modeling and analysis of biological networks
- Assess / Evaluate alternative methods for the study of biological networks
- Construct kinetic models of biological reactions

## Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Access and evaluate appropriate sources of information.
- Summarize an article or a technical report.
- Demonstrate the capacity for critical thinking
- Negotiate effectively within the group.

## Teaching methods

Teaching in classroom, paper reviews, project.

## Expected student activities

Presentations and critical analysis of papers.
Project.

## Assessment methods

- Presentations of papers from the literature (30%)
- Mid-semester and final project presentation (70%)

## Supervision

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| Office hours | Yes |
| Assistants | Yes |

## Resources

### Bibliography

Foundations of System Biology, Edited by Hiraoki Kitano. MIT Press 2001
Systems Biology, By Edda Klipp et al. Wiley-Blackwell 2009.
An Introduction to Systems Biology: Design Principles of Biological Circuits, by Uri Alon. Chapman and Hall/CRC 2006.
Computational Modeling of Genetic and Biochemical Networks, by James M. Bower and Hamid Bolouri. Bradford 2004.
Modeling Differential Equations in Biology, by Clifford H. Taubes. Prentice Hall 2000.

### Ressources en bibliothèque

- An Introduction to Systems Biology / Alon
- Modeling differential equations in biology / Taubes
- Foundations of System Biology / Nagasaki

- Computational Modeling of Genetic and Biochemical Networks / James
- Systems Biology in Practice / Klipp

### Websites

- http://scgc.epfl.ch/telechargement_cours_chimie