

## Modelling of Biological Systems (C003617)

**Course size** *(nominal values; actual values may depend on programme)*

**Credits 3.0** **Study time 80 h**

**Course offerings and teaching methods in academic year 2024-2025**

A (semester 1)	English	Gent	lecture seminar
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**Lecturers in academic year 2024-2025**

Maere, Steven	WE09	lecturer-in-charge
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**Offered in the following programmes in 2024-2025**

	crdts	offering
<a href="#">Master of Science in Bioinformatics(main subject Systems Biology)</a>	3	A
<a href="#">Master of Science in Biochemistry and Biotechnology</a>	3	A
<a href="#">Exchange programme in Biochemistry and Biotechnology (master's level)</a>	3	A
<a href="#">Exchange Programme in Bioinformatics (master's level)</a>	3	A

**Teaching languages**

English

**Keywords**

Computational biology, modelling of biological systems

**Position of the course**

Molecular biology traditionally focuses on the role of the individual biological components, including proteins and genes, in complex biological mechanisms. New "high-throughput" experimental techniques produce enormous amounts of data, which have made it possible to study the structure and dynamics of the complex gene and metabolic networks that the biological components form. DNA chips, or micro arrays, measure the activity of practically all gene in an organ or tissue simultaneously. This data can be analyzed and interpreted in roughly two ways. Top-down approaches start from data sets describing the whole system, and use data modeling techniques to identify patterns and putative system components. Bottom-up models start from the molecules or individual cells and their mutual interactions; they aim to reproduce the behavior of the system as a whole from the behavior of the individual components. This course focuses on bottom-up models of biological systems, in particular differential equation models, stochastic models and multiscale biological models.

This is an advanced course in the master of bioinformatics which focuses on the use of dynamic modeling of biological systems. The course will provide a theoretical background and illustrate the theoretical principles by means of examples in Bioinformatics (e.g. bottom up Differential Boolean networks, stochastic models en multiscale models).

**Contents**

- Bottom-up modeling
  - deterministic ODE modeling, bifurcation analysis, parameter estimation
  - noise and stochasticity, Gillespie modeling
  - predator-prey models, biological oscillations (e.g. cell cycle, circadian rhythms), switch-like behavior (e.g. developmental switches)
- Pattern formation and multiscale modeling, cell-based modeling of animal and plant development

### Initial competences

Basic knowledge of systems biology. Some insights into mathematical and statistical methodology will be useful.

Master in Bioinformatics: identical to those of the Master in Bioinformatics, Basic knowledge of systems biology. Some insights into mathematical and statistical methodology will be useful.

### Final competences

- 1 Knowledge of the standard methodology for bottom-up modeling of biological systems.
- 2 Choose and apply the appropriate data analysis technique for a given biological data set.
- 3 Critically evaluate computational methods in biological papers and interpret them for biologists.
- 4 Knowledge of the most important dynamical, theoretical models in cell biology and developmental biology.
- 5 Critically evaluate dynamical, theoretical models in the literature and interpret them.
- 6 Choose and develop appropriate model and modeling methodology for a given biological question.
- 7 Understanding of frequently used dynamical models.
- 8 Understanding of the general theoretical principles of dynamical modeling.
- 9 Modeling a biological problem with existing software and interpreting the results of the simulation/modeling.
- 10 Critical attitude towards the pro and cons of different tools.

### Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

### Conditions for exam contract

This course unit cannot be taken via an exam contract

### Teaching methods

Seminar, Lecture

### Study material

Type: Slides

Name: course slides

Indicative price: Free or paid by faculty

Optional: no

Language : English

Available on Ufora : Yes

Online Available : No

Available in the Library : No

Available through Student Association : No

Type: Software

Name: Matlab

Indicative price: Free or paid by faculty

Optional: no

Available on Athena : Yes

Online Available : No

Available in the Library : No

Available through Student Association : No

Additional information: Matlab is used in the practical sessions for analysis of dynamical systems.

Type: Other

Name: pdfs of scientific articles

Indicative price: Free or paid by faculty

Optional: no

Language : English

Available on Ufora : Yes

Online Available : No

Available in the Library : No

## References

The following list contains some background reading material, but we will primarily make use of journal articles

Eberhard O. Voit (2013) A first course in Systems Biology (Garland Science), ISBN 978-0-8153-4467-4)

Uri Alon (2006) An Introduction to Systems Biology (Chapman & Hall/Crc Mathematical and Computational Biology Series). ISBN: 1584886420

Bernhard O. Palsson (2006) Systems Biology: Properties of Reconstructed Networks. ISBN: 0521859034

## Course content-related study coaching

Interactive support via Ufora (forums, email). Personal advice: on appointment (by email).

## Assessment moments

end-of-term assessment

## Examination methods in case of periodic assessment during the first examination period

Oral assessment

## Examination methods in case of periodic assessment during the second examination period

Oral assessment

## Examination methods in case of permanent assessment

## Possibilities of retake in case of permanent assessment

not applicable

## Extra information on the examination methods

Oral exam with written preparation

## Calculation of the examination mark

Evaluation in exam periods (100%).