GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

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

Lecturers in academic year 2024-2025

Maere, Steven	WE09	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Bioinformatics(main subject Systems Biology)	3	A
Master of Science in Biochemistry and Biotechnology	3	A
Exchange programme in Biochemistry and Biotechnology (master's level)	3	A
Exchange Programme in Bioinformatics (master's level)	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 stucture 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 metholology 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 metholology 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

Available through Student Association : 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%).