GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2024-2025

Systems Biology (C003616)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	English	Gent	lecture seminar

Lecturers in academic year 2024-2025

De Rybel, Bert	WE09	lecturer-in-charge
Joossens, Marie	WE10	co-lecturer
Maere, Steven	WE09	co-lecturer
Saeys, Yvan	WE02	co-lecturer
Vandepoele, Klaas	WE09	co-lecturer

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Teaching in Science and Technology(main subject Biochemistry and Biotechnology)	4	A
Master of Science in Biochemistry and Biotechnology	4	A
Exchange programme in Biochemistry and Biotechnology (master's level)	4	A

Teaching languages

English

Keywords

Integrative biology, top-down and bottom-up systems biology, clustering, biological networks, gene network modelling, synthetic biology and single cell biology

Position of the course

Modern genetics and biotechnology is driven by large datasets; including whole genome sequencing, transcription factor binding site analysis at whole genome level; sequencing of microbial communities; metabolic pathway analysis and single cell biology. Other courses have focussed on the technological basis of acquiring such datasets, but the main question remains as to how we can make sense of all this big data. This course aims to provide the students with a broad overview of how different research fields use this data to extract meaningful biological information. We aim to provide an overview of methods to unravel this complexity by analysing and integrating systemwide functional genomics datasets. This course will also serve as a reference point to the students to allow them to make a more knowledgeable choice of more specialised courses in the final year of their studies.

Contents

- Lecture 1: **introduction and overview**: in the first lecture, we will give a general introduction into systems biology including a short historical perspective and provide a brief overview of the topics that will be covered during the course (Bert De Rybel)
- Lecture 2: **synthetic biology**: where biology meets engineering. We will introduce synthetic biology concepts borrowed from engineering and discuss design of synthetic systems using mathematical models, the technical pitfalls of introducing synthetic systems in living organisms and the state-of-the-art at the hand of recent papers. We will also discuss recent efforts to build synthetic genomes and to construct minimal genomes. We will also discuss ethical issues

surrounding synthetic biology (Steven Maere)

- Lecture 3: **gene regulation and network biology**: A general introduction on biological networks will be followed by an in-depth discussion on gene regulatory network analysis in eukaryotes. An overview of the different methods available to identify protein-DNA interactions in a high-throughput manner will also be discussed (Klaas Vandepoele)
- Lecture 4: **microbial systems biology:** The lecture on microbial systems biology will be an introduction on experimental and computational tools that are used for studying complex microbial ecosystems. Where systems biology in multicellular organisms focuses on crosstalk between different parts of the same organism, in complex microbial communities, the individual bacteria with their unique genetic background comprise the different parts that are integrated in microbial systems biology (Marie Joossens)
- Lecture 5: **single cell network biology**: With the rise of single cell biology, we will introduce the concepts and use of machine learning approaches in single cell network biology. We will explore the use of trajectory and gene regulatory network analysis (Yvan Saeys)
- Lecture 6: **extracting biological meaning** (from single cell data). The end-point of all systems biology approaches is to extract biologically meaningful results and novel insights from these large data-sets. In this lecture, we will use the example of single cell biology to illustrate the power of systems biology approaches to answer biological problems , but at the same time highlight its limitations (Bert De Rybel)
- Practical Course 1: Basic analysis of single cell RNA-seq data-sets.
- Practical Course 2: Using Cytoscape for network visualisation and basic network analysis of DNA-protein interaction data

The order of classes can be modified to fit the avaialbility of the teachers.

Initial competences

Basic knowledge of molecular biology, genetics, biochemistry, functional genomics and the associated technological platforms, as seen in the Bachelor Biochemistry-Biotechnology.

Final competences

1 The student will be capable of understanding the broad and general concepts of system biology approaches across different scientific fields.
2 The student will be knowledgeable about the different strategies that can be taken to analyse and understand large omics datasets and will acquire a basic practical understanding to initiate basic analyses on such datasets.
3 The student will get a basic insight into how the different analysis methods allow to retrieve biological meaningful information from large datasets and communicate this to a research team.
4 Given the broad overview concept of this course, the student will be able to make a knowledgeable choice towards more specialised courses that fit the interest of the student in the final year.

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

Extra information on the teaching methods

Traditional Lectures by experts in the respective fields; practical course via hands-on PC room classes

- Classroom lectures
- Practical course 1: Guided computer workshop
- Practical course 2: Guided computer workshop

Study material

Type: Slides

Name: Slides for each chapter will be made available on Ufora before each class
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

References

All articles referred to during the lectures and practical courses will be indicated on the Powerpoint slides and provided in pdf format through the Ufora platform or via PubMed.

Course content-related study coaching

See above Learning Materials

Assessment moments

end-of-term assessment

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

Written assessment with open-ended questions

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

Written assessment with open-ended questions

Examination methods in case of permanent assessment

Participation

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

End-of-term periodic evaluation via written exam of the theoretic part and practical course. Participation in practical courses is obligatory to pass the course.
In the case of restrictions regarding on-campus examination, the written exam format will be maintained using videoconferencing tools provided by the University.
Example exam questions will be communicated to the students at the end of the course to prepare for the written exam.

- Periodic evaluation: Written examination with 4-5 larger open questions or exercises complemented with a few smaller statements or terms that need be explained and commented on by the students.
- Permanent evaluation: There is no evaluation of the exercises and demos of the practical courses, but participation in the practical courses is obligatory. Some of the questions at the written exam can come from topics handled in the practical courses.

Calculation of the examination mark

Periodical written exam theoretical part: 100%