Module Name
Network modelling and machine learning – from genes to ecosystems

Type of Module	**Module Code**
o Advanced Module	Network modelling

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MN-B-SM (C 4)	360 h	12 CP	2nd term of studying	Summer term, 2nd half	Summer term only	7 weeks

1	**Course Types**	**Contact Time**	**Private Study**
	a) Lectures	34 h	82 h
	b) Practical/Lab	66 h	146 h
	c) Seminar	8 h	24 h

2 Module Objectives and Skills to be Acquired

Students who successfully completed this module

- Know how to implement advanced machine learning algorithms for biological data analysis and interpret complex biological datasets with a special focus on genomics.
- Can explain the concept of metabolism as a network of coupled reactions which turn over metabolites. Coming from the understanding of key aspects of enzymatic reactions they will be able to model metabolism at a network scale from the cellular to the ecosystem level
- Can identify and interpret general dynamic phenomena and their relevance in biology, in particular regarding the stability of ecosystems

3 Module Content

- Network theory, simulation methods, and theory of dynamic systems
- Encoding and embedding of genomic data for machine learning
- DNA language models
- Constraint-based optimization techniques for metabolic networks, metabolic network reconstruction and contextualization through omics-data integration

4 Teaching Methods

- Lectures; Practical; Seminar; Computer exercises (Project work); Guidance to independent research; Training on presentation techniques in oral and written form

5 Prerequisites (for the Module)

Enrollment in the Master's of Science degree course "Computational Biology"

Additional academic requirements

Previous attendance of the lecture module Computational Biology; good knowledge of quantitative methods and good mathematical skills are indispensable to participate in this module. Basic knowledge of Python is required.

6	**Type of Examination** The final examination consists of two parts: Two hour written examination about topics of the lectures (70 % of the total module mark), oral presentation (30 % of the total module mark)
7	**Credits Awarded** Regular and active participation; Each examination part at least "sufficient" (see appendix of the examination regulations for details)
8	**Compatibility with other Curricula** None
9	**Proportion of Final Grade** 12.0 %
10	**Module Coordinator** Prof. Dr. Nadine Töpfer, phone 470 89648, e-mail: ntoepfer@uni-koeln.de
11	**Further Information** **Participating faculty**: Prof. Dr. Nadine Töpfer, Prof. Dr. Thomas Wiehe, Dr. Gerrit Ansmann, Prof. Dr. Anna Pötsch **Literature:** • Information on recommended textbooks and other reading material will be given on the ILIAS representation of the course • Additional original papers will be handed out during the module **General time schedule:** Weeks 1–6 (Mon. 13–14:30, Tue 9-14:30 Wed 13-16:30, Thu 15-16:30, Fri 13-16:30): Lectures, seminars, computational exercises, and preparation for the examination. **Note:** The module includes hands-on computational work conducted in class as well as during private study times. **Introduction to the module:** June, 1st 2026 COMB building (301), room 0.34 ground floor Computer pool (ground floor) **Oral examination:** July 24, 2026; second/supplementary examination August 28, 2026; dates may vary if students and module coordinator agree. More details will be given at the beginning of the module.