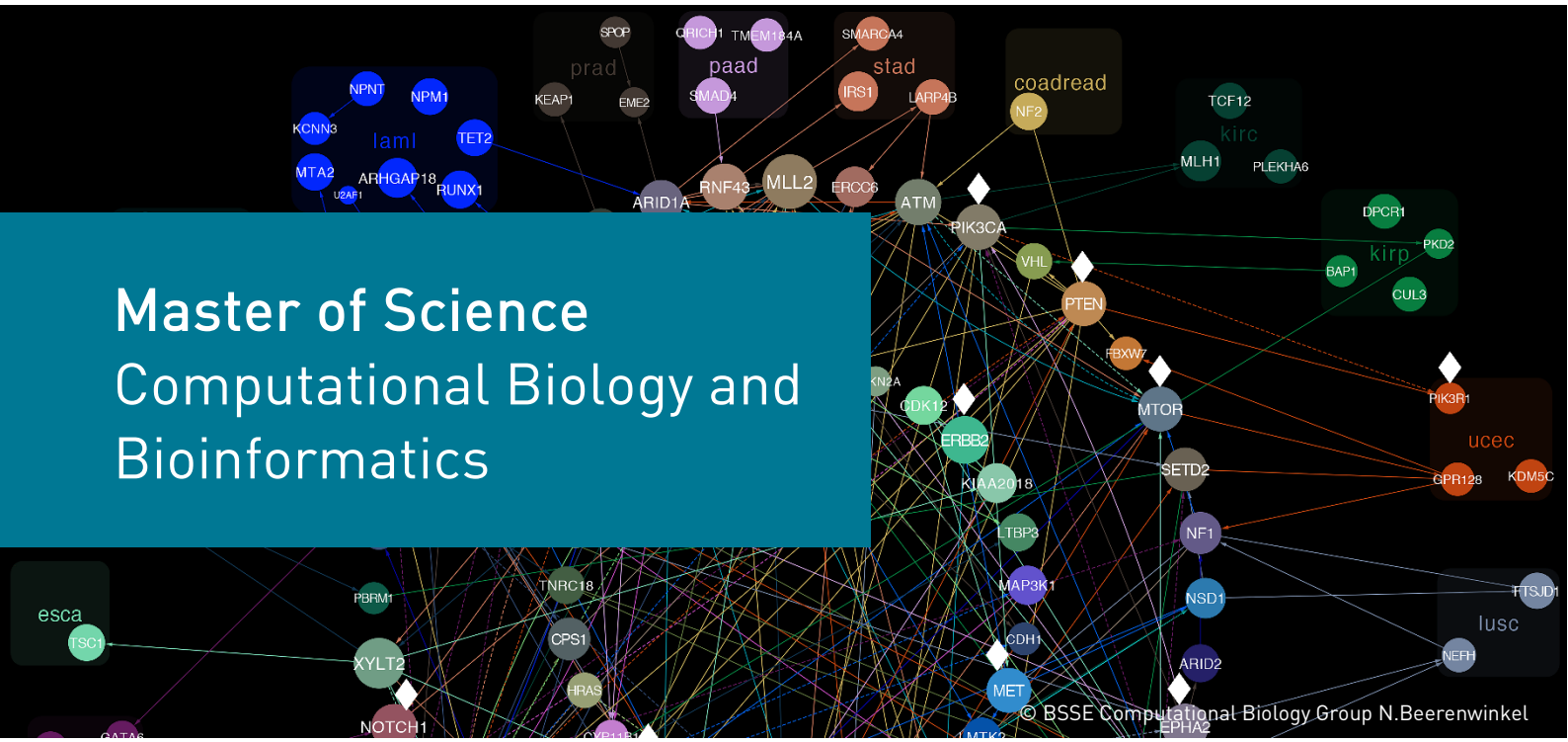
ETH zürich | University of Basel | University of Zurich[UZH]

Department of Biosystems Science and Engineering



Master of Science
Computational Biology and Bioinformatics

Computational Biology and Bioinformatics is an interdisciplinary domain where procedures and methods from computer science are developed and deployed to address and solve important current problems in biology.

Computational biology and bioinformatics complement the experimental biosciences with quantitative modelling and data analysis at high complexity as needed for living systems. The recent development of experimental methods, such as next generation sequencing or high-resolution imaging, gives insight into cellular systems at unprecedented detail. The generation of large-scale datasets, as well as the increasing need to analyse and design highly complex biological systems, have opened a new frontier of research with fundamental scientific challenges. For instance, methods that can be scaled to the various complexity levels of biology are required to ensure validated scientific results. New algorithmic techniques have to be explored to be able to extract information from large datasets.

The CBB programme enables students to contribute to this fascinating and vivid scientific area by fostering them to become experienced, creative, and efficient problem solvers in computational biology and bioinformatics, equipped with advanced methodological and conceptual knowledge to deal with the problems of tomorrow.

The master's degree programme in Computational Biology und Bioinformatics is a specialised degree programme jointly offered by ETH Zurich, University of Basel, and the University of Zurich. It is a young, interdisciplinary programme for tomorrow's leaders in life science research at the intersection of biology and computer science. The primary goal is to provide a broad education in computational biology and bioinformatics based on a solid background in computer science, biology, and relevant mathematical approaches.

Language of instruction
English

Credits | duration
120 ECTS | 2 years

Academic title
Master of Science ETH UZH UNIBAS in Computational Biology and Bioinformatics

Location
Zurich and Basel
Lectures can be attended both in Zurich and in Basel. Nearly all credits can be covered in either of the two cities alone.

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Curriculum Structure

The master's degree programme in Computational Biology and Bioinformatics focuses on the development of mathematical concepts and computational methods, and their applications in the life sciences. Lab rotations and the master's thesis allow for application of the knowledge in computational methods as well as for obtaining practical experience in experimental biology. The programme places particular emphasis on the systematic integration of experimental biology and data generation.

The structure of the programme aims at an optimal trade-off between the breadth of education and specialization with flexibility according to the student's own choices.

The programme is built on the following aspects:

It provides **intensive training in foundational methods and concepts** that enable addressing key scientific challenges associated with the increasing need to analyse and design highly complex biological systems. Theory courses cover methods in computer science and applied mathematics in areas such as modelling, optimisation, and data analysis. To enable the successful application of computational biology and bioinformatic approaches, biology courses complement the quantitative foundations with a wide range of topics from areas of modern biology such as genetics, genomics, stem cell biology, or cancer biology.

The programme's core courses are designed to **combine methods and applications** in four essential areas of computational biology and bioinformatics:

Bioinformatics: analysis of DNA/RNA and protein sequences, for example in comparative genomics and molecular evolution.

Biophysics: analysis of structures and functions of biomolecules, and development of models for biomolecules such as proteins.

Biosystems: modelling and analysis of biological networks in a systems-oriented view, for example to elucidate disease mechanisms.

Big Data: data science approaches such as machine learning to integrate and analyse large biological data sets, for example for personalized health.

The programme's flexible, short research projects (lab rotations or industry internships) **provide a practical overview of different research areas** and prepare for further specialisation through the master's thesis. These practice-oriented rotations also help training transferable skills such as interdisciplinary communication, collaboration, and critical thinking.

The programme is mentor-driven. During the first semester, students select a mentor who will advise them in compiling their individual curriculum. The mentoring system aims at providing an excellent, specialized education, while granting sufficient flexibility to meet the expectations and needs of students. The varied course selection and individual study plan provide a flexible study programme.

1st semester	2nd semester	3rd semester	4th semester	ECTS
Core Courses & Mandatory CBB Seminar Bioinformatics | Biophysics | Biosystems | Big Data				40
Advanced Courses Theory | Biology				30
Science in Perspective				2
	Lab Rotations/Industry Internship *completed during or between semesters*			18
			Master's Thesis	30
TOTAL				**120**

Core Courses (40 ECTS)

Students attend courses within each of the four core course areas:

- Bioinformatics
- Biophysics
- Biosystems
- Big Data

Attendance of one mandatory seminar (2 ECTS).

Advanced Courses (32 ECTS)

This area encompasses courses in:

- Theory (at least 16 ECTS)
- Biology (at least 10 ECTS)

Science in Perspective (2 ECTS): enrichment of students' general education

Lab Rotations (18 ECTS)

Flexible, short research projects (total 12 weeks) in which students gain an overview of different research areas by applying concepts taught in the core courses and advanced courses. Students may complete a project in a research group or an industry internship.

Master's Thesis (30 ECTS)

A research project of 24 weeks duration, including a written report and an oral presentation.

Flexible course selection and mentor-based studies programme

Qualification profile

The master's degree programme in Computational Biology and Bioinformatics imparts knowledge and skills regarding the computational analysis of biological data and systems. Graduates of the programme can deploy theories, methods, techniques and tools from bioinformatics, biophysics, systems biology, and the data sciences professionally and responsibly. They can acquire new knowledge and skills in these rapidly developing interdisciplinary areas independently.

The master's degree qualifies its holders for positions in the pharmaceutical and biotechnology industries and in clinics and clinically focused enterprises that focus on or require software development and data analysis. Successful students are excellent prepared for academic careers.

Subject-specific knowledge and skills: graduates possess in-depth knowledge in bioinformatics, biophysics, systems biology, and the data sciences and have a broad understanding of the sequences, structures, and systems they are analysing.

Analytical skills: graduates can systematically comprehend and analyse application problems from biological research and are able to assess the relevance of theoretical concepts and experimental methods to fundamental research issues in biology, medicine, and biotechnology.

Development skills: graduates can apply computational methods and models and their foundational theories to biology research issues in a solution-oriented manner and can contribute to the fast assimilation of new material in the rapidly developing fields of computational biology, bioinformatics and (molecular) biology.

Personal and social competences: graduates master a variety of transferable and social skills. They can clearly communicate concepts, problems, and solutions in written and oral form to specialists and lay persons. They are able to produce scientific work independently and present research results to an interdisciplinary audience in the form of scientific talks and posters. Graduates are further able to collaborate in a solution-oriented manner with specialists from neighbouring fields such as biology, computer science and mathematics, and they can relate the specialist literature to their own research and reflect critically on it.

Job perspectives of graduates from the ETH master's degree programme in Computational Biology and Bioinformatics are excellent. Typical careers include employment and entrepreneurship in the pharmaceutical and biotechnological industry, including the major global players headquartered in Basel and the strong Swiss start-up sector in the biotechnology field, but also in a broad variety of other sectors ranging from software engineering, bioinformatics, and data analysis from pharma to IT and consulting. About half of the graduates continue to pursue doctoral studies inside and outside of the department.

Application & Admission

Excellent students holding a bachelor's degree in Computer Science, Bioinformatics, Biology, Natural Sciences, Engineering, Biomedicine, and other disciplines with a strong theoretical-mathematical background are welcome to apply. A minimum background in biology, computer science and mathematics is mandatory for all students.

The admission committee may issue additional requirement courses to students whose bachelor's degree curriculum does not fulfil all admission criteria. Additional requirement courses need to be taken in addition to the regular master's degree programme.

This master's degree programme is offered in cooperation with the University of Basel and the University of Zurich. Applications are handled by ETH Zurich.

Further information

MSc CBB programme
Programme Website

Department of Biosystems Science and Engineering
D-BSSE Website

Application process and admission prerequisites
ETH Zurich Admissions Office

Financial aspects & tuition fees
ETH Financial Aid Office

Studies at ETH
ETH Student portal

Information for international students
ETH International Student Office

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