Master of Science in Quantitative and Computational Biology
Master in Quantitative & Computational Biology

A joint initiative between:

- Centre for integrative biology (CIBIO)
- Department of Physics
- Department of Mathematics
- Department of Information Engineering and Computer Science (DISI)
Capturing the increasing need for researchers/experts able to:

• transform the enormous amount of biological information ("big data") into knowledge
• gain quantitative insight into the behaviour of biological systems by means of bio-mathematical and bio-physical models

SPOTLIGHT ON BIOINFORMATICS

Biology goes digital
A new species of biologist is beginning to thrive in the niche created by recent genomic and computational advances.
For life scientists with expertise and an interest in bioinformatics, computer science, statistics, and related skill sets, the job outlook couldn’t be rosier.

Big data is pouring out of life sciences research, creating ample opportunities for scientists with computer science expertise.

Big pharma, biotech, and software companies are clamoring to hire professionals with experience in bioinformatics and the identification, compilation, analysis, and visualization of huge amounts of biological and health care information.
High job market demand

- Quantitative biology 680
- Computational biologist/biology 2200
- Bioinformatics/bioinformatician 6200
- Biophysics 890
Navigating big data, to maximize its utility, will require specially designed training programs directed at early-career scientists.

“The opportunities are enormous for budding computer scientists, mathematicians, and engineers to meld with trainee biologists, neuroscientists, and clinicians in novel university courses constructed to focus on the truly 21st century phenomenon that is the data avalanche from large-scale biomedicine.”
Exploiting key competences in Biology, Engineering and Computer Science, Mathematics, Physics available in Trento
The Department of Cellular, Computational and Integrative Biology

CANCER BIOLOGY & GENOMICS

CELL & MOLECULAR BIOLOGY

MICROBIOLOGY & SYNTHETIC BIOLOGY

NEUROBIOLOGY & DEVELOPMENT

ADVANCED IMAGING
HIGH THROUGHPUT SCREENING & MICROARRAY
BIO-ANALYTICAL MASS SPECTROMETRY
PROTEIN SCIENCE
LAB MANAGEMENT TEAM

CELL ANALYSIS & SEPARATION
NEXT GENERATION SEQUENCING
MODEL ORGANISM
BIOINFORMATICS
GRANT SUPPORT

Higher education
Research center
Biomedicine
Core facilities
Biotechnology
Research & Innovation
Molecular basis of diseases
Independent PIs
Computational Biology

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Molecular basis of diseases
Independent PIs
Computational Biology
Physics Department

Fundamental and applied fields of study

- Experimental Gravitation
- Biophysics and Biosignals
- Bio-organic Chemistry
- Communication of Physical Sciences
- Atomic and Molecular Physics
- IdEA (Hydrogen, Energy, Environment)
- Structure and dynamics of complex systems
- Nanoscience
- Theoretical and computational physics

partner institutions

[TIFPA] [Consiglio Nazionale delle Ricerche] [BEC] [ECT*]

-European Centre for Theoretical Stud in Nuclear Physics and Related Areas-
The Department of Information Engineering and Computer Science

Founded in January 2002 as a dynamic and qualified response to the ever-increasing, leading-edge competency demands in the field of ICT, drawing from a productive fabric at the local, national and international level.
Mathematics Department

- Analytic and Algebraic Geometry
- Calculus of Variations and Geometric Measure Theory
- Dynamical Systems and Control Theory
- Lie Algebras, Groups, Cryptography and Codes
- Mathematical Logic and Theoretical Computer Science
- Mathematical Physics and Geometrical Methods in Physics
- Nonlinear Partial Differential Equations
- Numerical Approximation of Partial Differential Equations
- Stochastic Processes

- Laboratory of Didactics and Communications of Mathematics
- Laboratory of Industrial Mathematics and Cryptography
- Laboratory of Mathematical and Computational Biology

The Microsoft Research – University of Trento Centre for Computational and Systems Biology

CIRM
CENTRO INTERNAZIONALE PER LA RICERCA MATEMATICA

COSBI

TIFPA

Trento Institute for Fundamental Physics and Applications

iNSAM
Istituto Nazionale di Alta Matematica
from "big data" to knowledge

quantitative insight by means of biomathematical and biophysical models
Admission

First level University Degree in:
- Biotechnology
- Biological Sciences
- Science and agro-food technologies
- Pharmaceutical and Technological Sciences
- Chemical and Technological Sciences
- Physical and Technological Sciences
- Mathematical Sciences
- Information Sciences and Technology
- Information Engineering

...plus

basic knowledge and skills in computer science, mathematics, physics, chemistry and biology

+ **English B1**
Courses

• **Mandatory Courses:** to allow students from different educational paths to harmonize their background (24 CFU/ECTS) and to acquire specific competencies (24 CFU/ECTS)

• **Elective courses:** to focus on selected biotechnological or computational topics (36 CFU/ECTS)

• **Free choice courses:** among courses offered by the UniTN Departments (12 CFU/ECTS)

• **Language**, English B2 or higher (3 CFU/ECS)

• **Traineeship** within the University of Trento organizations involved in the Master Degree, by other Italian or European Universities, or in industries operating in the biotechnology, bioinformatics and computational area (6 CFU/ECTS)

• **Thesis** (usually related to the traineeship activity; 15 CFU/ECTS)

**Total** 120 CFU/ECTS
Courses are mostly composed by two integrated modules (6 CFU/ECTS each)
### Biotechnological track: mandatory

<table>
<thead>
<tr>
<th>I year</th>
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<tbody>
<tr>
<td>I semester</td>
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#### I year
- Mol. Basis of Cell Structure & Function
- Cellular & Molecular Dynamics
- Organic & Biological Chemistry
- Experim & Computational Biochemistry
- Biostatistics & Probability
- Biostatistical Computing
- Scientific Programming
- Algorithms & Data Structures
- Quantum Physics
- Quantum Chemistry
- Computational Human Genomics
- Computational Microbial Genomics
- Genetic & Metabolic Engineering
- Tissue Engineering
- Network-based Data Analysis
- Network Modeling & Simulation
- Algorithms for Bioinformatics
- Bioinformatic Resources
- Non-equilibrium statistical physics
- Multi-scale methods in soft matter

#### II year
- Mathematical Modeling in Biology
- Spatio-temporal Models in Cell & Tissue Biology
- Physical Modeling of Biomolecules
- Computer Simulation of Biomolecules
- Machine Learning
- Biological Data Mining
- Economics & Management
- Biotechnology Regulations
- Statistical Models
- Stochastic Processes
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### II year - I semester

- **Mathematical Modeling in Biology**
- **Spatio-temporal Models in Cell & Tissue Biology**
- **Physical Modeling of Biomolecules**
- **Computer Simulation of Biomolecules**
- **Machine Learning**
- **Biological Data Mining**
- **Economics & Management**
- **Biotechnology Regulations**
- **Statistical Models**
- **Stochastic Processes**
### Computational track: 3 electives

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**Physical track: 3 electives** (tot of 36 CFU)

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BSc in Bio, Comp Sci, Math, Phys

- Biotechnological Track
- Computational Track
- Physical Track

- Mandatory
- Electives
- Free choice
- Language
- Traineeship
- Thesis

Biotechnologists
Informaticians
Data and Systems Biology Analysts
Computational Biologists

international.unitn.it/mqcb
Professional profiles at outcome

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<tr>
<td>✓ Skills in experimental techniques and instrumentation and deep understanding of cellular and molecular processes</td>
<td>✓ Development of software and computational tools for biological data analysis</td>
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<td>✓ Skills in dedicated software for laboratory equipment and raw data management</td>
<td>✓ Skills in complex databases, web resources and in cluster- or cloud-based computational solutions</td>
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<td>✓ Effective interaction both with laboratory personnel and analysts and ability to integrate workflows</td>
<td>✓ Building and maintaining workflows and pipelines for raw biomolecular data analysis and integration</td>
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<th><strong>DATA AND SYSTEMS BIOLOGY ANALYST</strong></th>
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<td>✓ Development of analytical methods for large-scale data (genomics, proteomics, metabolomics) and molecular interaction models</td>
<td>✓ Skills in biostatistics for experimental design and advanced analysis of clinical and molecular data</td>
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<tr>
<td>✓ Identification, development and test of computational methods for the discovery of active ligands and for drug development</td>
<td>✓ Curation of high-dimensional data for the representation of biological knowledge by integrated systems and biological networks</td>
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<tr>
<td>✓ Design of in silico experiments to test data-driven hypotheses and interpretation of result</td>
<td>✓ Analysis of complex biological data derived from whole-cell measurements</td>
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Multiple opportunities for internships
Join us!

https://offertaformativa.unitn.it/en/lm/quantitative-and-computational-biology

- Application deadline: 13th June
- 45 positions
- Degree certificate not later than 31st October, 2018