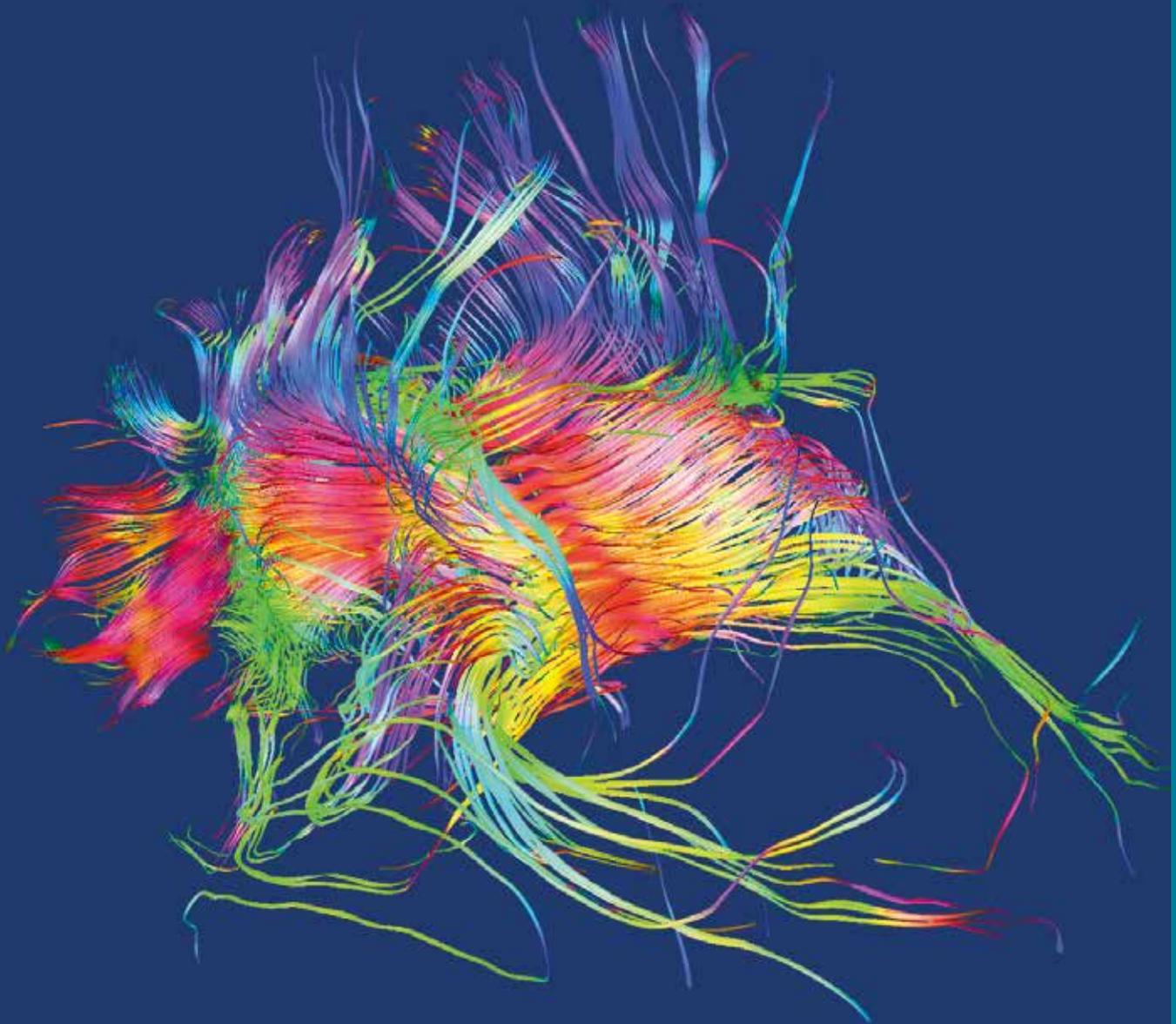


# Master

## Biomedical Engineering



## Welcome

The Master of Science in Biomedical Engineering at the ETH Zurich in Switzerland was created to meet the growing need for interdisciplinary scientists trained to work at the interface between biology, medicine, engineering and physics. The ETH, University Hospital of Zurich and Paul Scherrer Institute provide a fertile ground for innovative biomedical engineering research, numerous BioTech spin-offs and several interdisciplinary academic programs. The MSc Biomedical Engineering program at ETH Zurich draws its curricula from eight different departments and provides individually tailored training in one of five subdivisions (tracks) within biomedical engineering:

- Bioelectronics
- Bioimaging
- Biomechanics
- Medical Physics
- Molecular Bioengineering



# Curriculum Structure

90 credit points are required to obtain a Master of Science ETH in Biomedical Engineering. According to the European Credit Transfer System (ECTS), each credit point corresponds to approximately 25-30 hours of work. Generally, the Master degree takes 3 to 4 semesters to be completed.

In most instances, the classroom course work is completed in the first two semesters of the program. The semester project requires a 50% work load and is generally done in the second semester of the program. The program typically finishes with a 6-month Master thesis project, which can be done either in an academic laboratory, or at industry. Topics for research projects can be found on the websites of the program-associated institutes and laboratories (page 12-13).

## Track Advisor

The five tracks or specializations within the MSc in Biomedical Engineering are described on pages 7-11. Every track is headed by at least one track advisor, who is an expert in the scientific area and who is available to advise and support you during your studies.

Program website: [www.master-biomed.ethz.ch](http://www.master-biomed.ethz.ch)

## Track Courses (50 credit points)

Each track represents an area of specialization within the larger field of biomedical engineering.

- 1. Track core courses** (at least 12 credits)  
These courses are at the core of each track.
- 2. Recommended elective courses**  
These courses complement and expand the track.
- 3. Biology courses**  
For students without prior experience in cell and molecular biology, physiology and anatomy, and who have no training in basic laboratory techniques (e.g. DNA and RNA isolation, protein isolation and identification, cell culture).

## Semester Project (8 credit points)

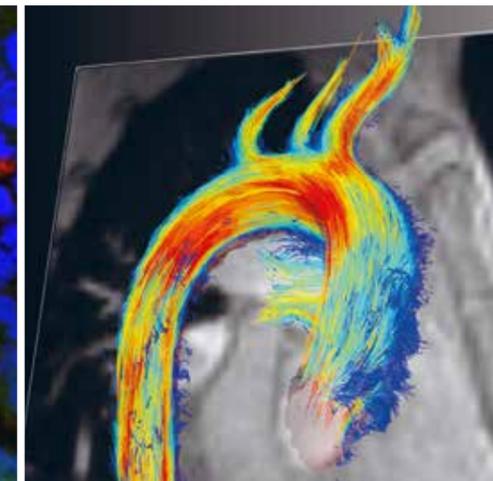
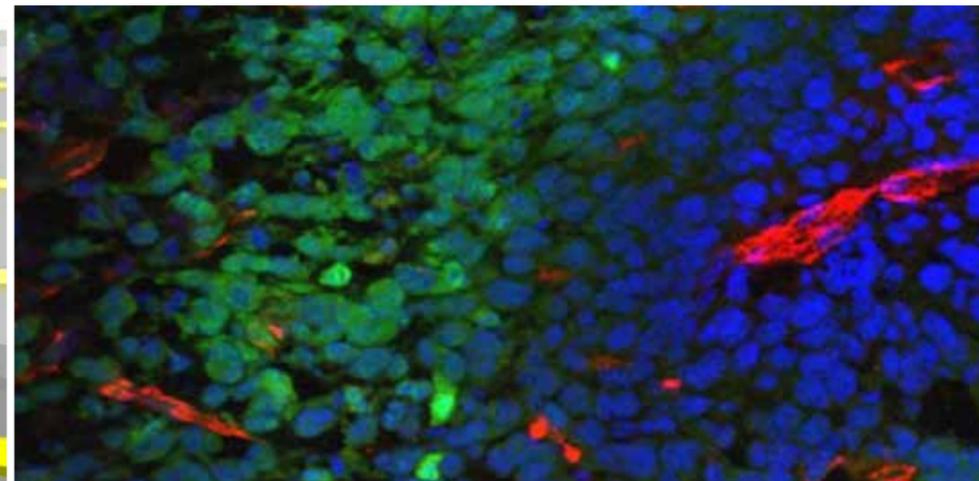
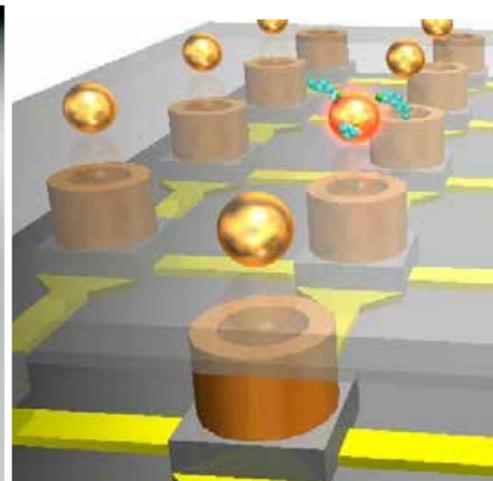
The semester project gives students hands-on research experience in their chosen specialization. The project is supervised by a professor who is associated with one of the four participating departments.

## Humanities (2 credit points)

Courses chosen from the Department of Humanities, Social Sciences and Political Science (D-GESS) which enrich the student's general education.

## Master's Thesis (30 credit points)

The Master program culminates in a 6-month research project which addresses a scientific research question in one's chosen area of specialization. The Master thesis is guided and supervised by a program-affiliated faculty member.



# Individual Study Plan

At the beginning of the first semester, the student will set up an individual study plan, in collaboration with the track advisor. This plan selects the track core, elective as well as the biology courses that the student will attend and must pass. All lectures and courses of each specialization are published on the website of the program, and in the course catalogue of ETH. In addition, students can also suggest other lectures, which have to be approved by the track advisor.

Course catalogue: [www.vz.ethz.ch](http://www.vz.ethz.ch)

The core courses as well as the recommended elective courses are at an introductory or at an advanced level, and cover the chosen area of specialization. The biology courses give introductory lectures to cell- and molecular biology, as well as human anatomy and physiology. In addition, the student will learn in a laboratory course current biological techniques, including mammalian cell culture and in vitro work with RNA, DNA and proteins. The biology courses are only intended for students who do not have prior knowledge in these fields.

# Bioelectronics

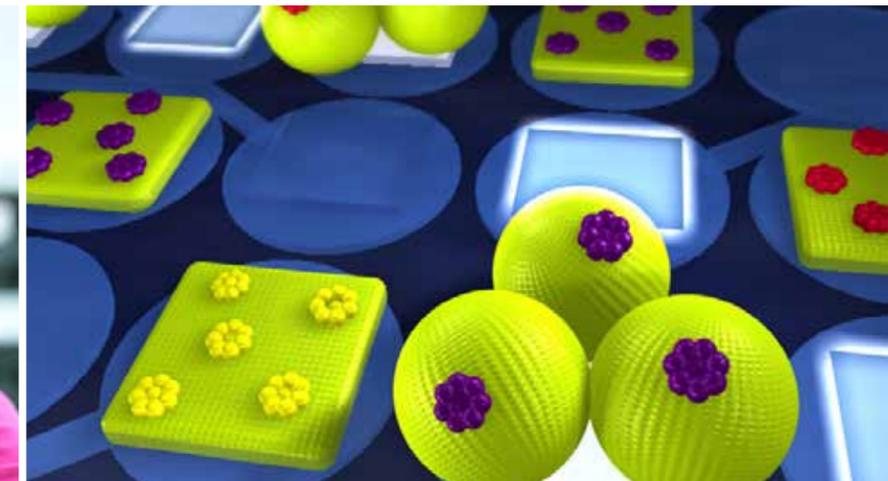
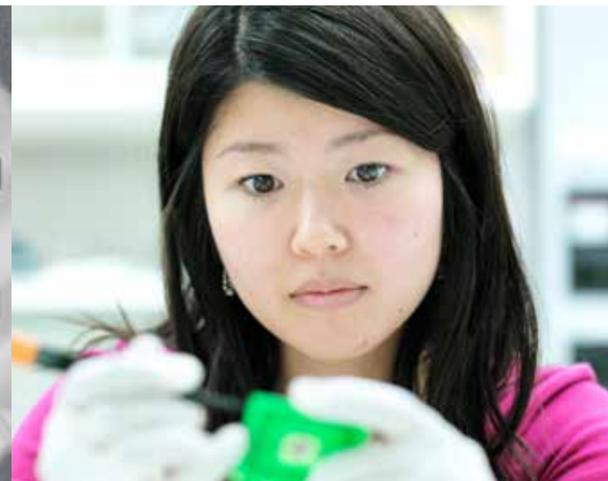
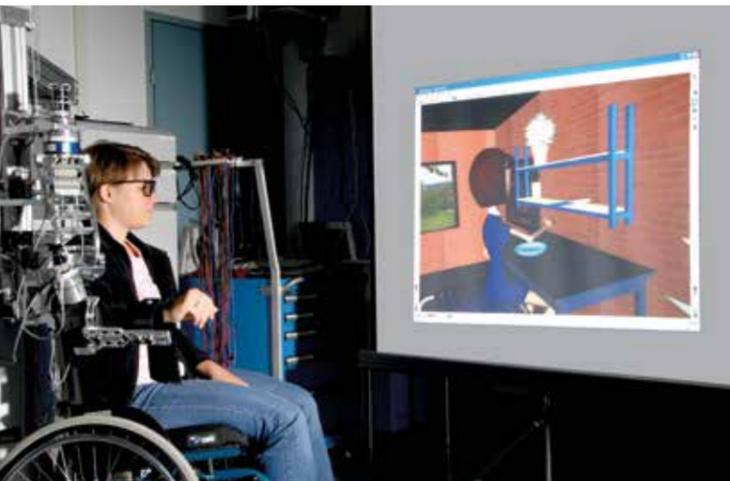
## Track Advisor

**Prof. Janos Vörös**  
[janos.voros@biomed.ee.ethz.ch](mailto:janos.voros@biomed.ee.ethz.ch)

This track provides in-depth knowledge of the development and use of instruments and signal processing theory to measure physical, physiologic or biologic signals in humans and other living organisms. The development of instrumentation is based on technologies including bioMEMS, micro- and nanosystems, biophotonics, sensors, optics and micro-fluidics. These technologies are applied to a wide array of instruments and devices including hearing aids, biosensors, labs-on-a-chip, and electrograms. The course program can be found at:  
[www.master-biomed.ethz.ch/education/focus/Bioelectronics](http://www.master-biomed.ethz.ch/education/focus/Bioelectronics)

## Core Courses

- Biocompatible Materials I: Molecular Aspects and Fundamentals
- Biomedical Engineering
- Biomedical Imaging
- Biosensors and Bioelectronics
- Introduction to Neuroinformatics
- Microrobotics
- Microsystem Technology
- Nanosystems
- Physics in Medical Research: From Atoms to Cells
- Signal and Information Processing: Modeling, Filtering, Learning



# Bioimaging

## Track Advisor

**Prof. Klaas Prüssmann**  
[pruessmann@biomed.ee.ethz.ch](mailto:pruessmann@biomed.ee.ethz.ch)

This track prepares you to work in the development and application of state-of-the-art imaging techniques such as magnetic resonance, ultrasound and micro-computed tomography. These methodologies are used to explore physiology and pathophysiology in humans and other living systems. Bioimaging has made enormous contributions to the diagnosis of human illnesses such as cardiac disease, Alzheimer's disease and osteoporosis. The current course program can be found at:  
[www.master-biomed.ethz.ch/education/focus/Bioimaging2](http://www.master-biomed.ethz.ch/education/focus/Bioimaging2)

## Core Courses

- Biomedical Engineering
- Biomedical Imaging
- Image Analysis and Computer Vision
- Magnetic Resonance Imaging in Medicine
- Micro- and Nano-Tomography of Biological Tissues
- Molecular Imaging – Basic Principles and Biomedical Applications
- Quantitative and Analytical Light Microscopy Computer

# Biomechanics

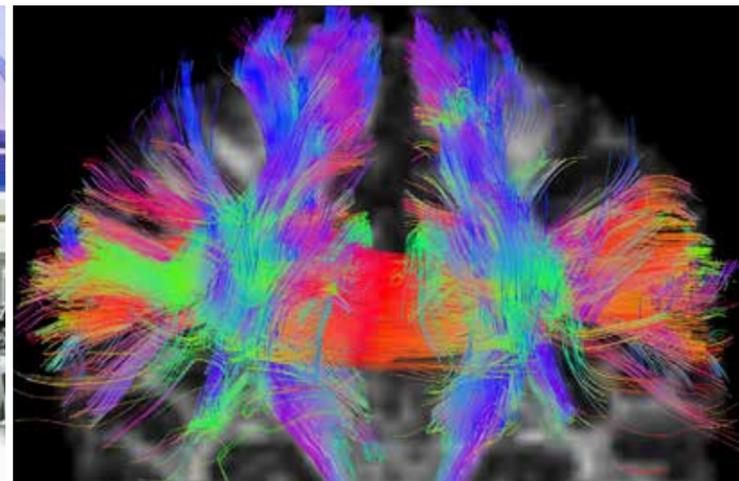
## Track Advisor

**Prof. Ralph Müller**  
[ram@ethz.ch](mailto:ram@ethz.ch)

This track gives you in-depth knowledge about the application of mechanics and measurement methods for understanding the structure and function of biological materials at the organism, organ, tissue, cell, and molecular level. The track includes many application fields ranging from cell biomechanics to fracture fixation and provides education and hands-on research opportunities in theoretical, experimental and computational biomechanics. Biomechanics is a discipline of biomedical engineering which is increasingly influenced by cellular and molecular approaches. The course program can be found at:  
[www.master-biomed.ethz.ch/education/focus/Biomechanics](http://www.master-biomed.ethz.ch/education/focus/Biomechanics)

## Core Courses

- Biomechanics III & IV
- Biomedical Engineering
- Biomedical Imaging
- Image Analysis and Computer Vision I
- Mechanobiology: Implications for Development, Regeneration and Tissue Engineering
- Micro- and Nano-Tomography of Biological Tissues
- Orthopaedic Biomechanics
- Trauma Biomechanics



## Medical Physics

### Track Advisor:

**Prof. Tony Lomax**  
[alomax@ethz.ch](mailto:alomax@ethz.ch)

**Prof. Marco Stampanoni**  
[stampanoni@biomed.ee.ethz.ch](mailto:stampanoni@biomed.ee.ethz.ch)

This track concentrates on the applications of physics to medical applications in radiotherapy and imaging. In addition to core lectures on medical imaging and radiotherapy, the track provides lectures on radiation biology and professional aspects of medical physics, together with various options in medical physics related subjects like hadron therapy and applied physics in the fight against cancer. Master theses can be performed at PSI, ETH or various hospital based medical physics departments in Switzerland. The current course program can be found at:  
[www.master-biomed.ethz.ch/education/focus/Medical\\_physics](http://www.master-biomed.ethz.ch/education/focus/Medical_physics)

### Core Courses:

- Biomedical Imaging
- Medical Physics I & II
- Introduction to Medical Physics
- Radiation Biology

## Molecular Bioengineering

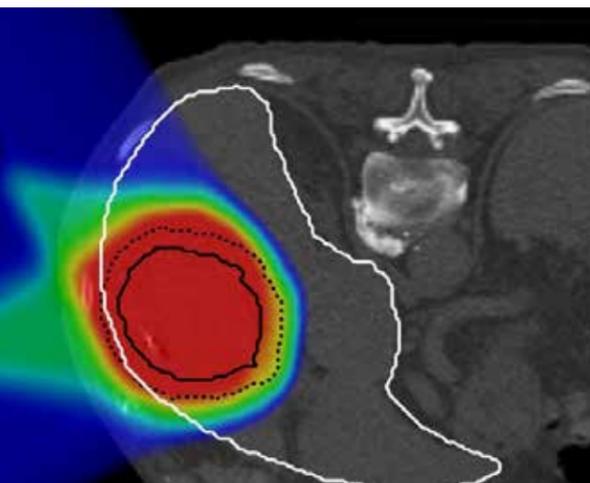
### Track Advisor:

**Prof. Marcy Zenobi-Wong**  
[marcy.zenobi@hest.ethz.ch](mailto:marcy.zenobi@hest.ethz.ch)

This track concerns the science and engineering behind the next generation of materials. Research topics include advancing the performance of medical implants, engineered tissues, nanoscale drug delivery systems, contrast agents for biomedical imaging, biologically inspired nanomaterials and devices, and the interfacing of cells with engineered nanosystems. The current course program can be found at:  
[www.master-biomed.ethz.ch/education/focus/MolBio](http://www.master-biomed.ethz.ch/education/focus/MolBio)

### Core Courses:

- Biocompatible Materials I & II
- Biological Engineering and Biotechnology
- Biostatistics
- Frontiers in Nanotechnology
- Fundamental of Biology IIA: Cell Biology
- Introduction to Bioinformatics: Concepts and Applications
- Measuring on the Nanometer Scale
- Mechanobiology: Implications for Development, Regeneration and Tissue Engineering
- Physics in Medical Research: From Atoms to Cells
- Quantitative and Analytical Light Microscopy



# Institutes and Laboratories

Over 40 professors and researchers are associated with the MSc Biomedical Engineering program through teaching, research and supervision of student research projects. Currently available Master and Semester project topics can be found under the individual web-sites as well as at: [www.biomed.ee.ethz.ch](http://www.biomed.ee.ethz.ch)

The following institutes and research laboratories are associated with the program:

**Laboratory of Applied Mechanobiology**  
[www.appliedmechanobio.ethz.ch](http://www.appliedmechanobio.ethz.ch)

**Institute of Biochemistry**  
[www.bc.biol.ethz.ch](http://www.bc.biol.ethz.ch)

**Institute for Biomechanics**  
[www.biomech.ethz.ch](http://www.biomech.ethz.ch)

**Institute for Biomedical Engineering**  
[www.biomed.ee.ethz.ch](http://www.biomed.ee.ethz.ch)

**Bioengineering and Biotechnology Laboratory**  
[www.bsse.ethz.ch](http://www.bsse.ethz.ch)

**Bioprocess Laboratory**  
[www.bsse.ethz.ch/bpl](http://www.bsse.ethz.ch/bpl)

**Cartilage Engineering & Regeneration**  
[www.cartilage.ethz.ch](http://www.cartilage.ethz.ch)

**Institute for Chemical and Bioengineering**  
[www.icb.ethz.ch/](http://www.icb.ethz.ch/)

**Computational Science and Engineering Laboratory**  
[www.cse-lab.ethz.ch/](http://www.cse-lab.ethz.ch/)

**Computer Vision Laboratory**  
[www.vision.ee.ethz.ch](http://www.vision.ee.ethz.ch)

**Institute of Fluid Dynamics**  
[www.ifd.mavt.ethz.ch](http://www.ifd.mavt.ethz.ch)

**Laboratory of Food Process Engineering**  
[www.ifnh.ethz.ch](http://www.ifnh.ethz.ch)

**Institute for Mechanical Systems**  
[www.imes.ethz.ch](http://www.imes.ethz.ch)

**Micro- and Nanosystems**  
[www.micro.mavt.ethz.ch](http://www.micro.mavt.ethz.ch)

**Institute of Molecular Health Sciences**  
[www.imhs.ethz.ch](http://www.imhs.ethz.ch)

**Nanophysics Group**  
[www.nanophys.ethz.ch](http://www.nanophys.ethz.ch)

**Nanotechnology Group**  
[www.nano.mavt.ethz.ch](http://www.nano.mavt.ethz.ch)

**Institute of Neuroinformatics**  
[www.ini.unizh.ch](http://www.ini.unizh.ch)

**Institute of Pharmaceutical Sciences**  
[www.pharma.ethz.ch/](http://www.pharma.ethz.ch/)

**Centre for Proton Therapy at Paul Scherrer Institut (PSI)**  
[www.psi.ch](http://www.psi.ch)

**Institute of Robotics and Intelligent Systems**  
[www.iris.ethz.ch](http://www.iris.ethz.ch)

**Signal and Information Processing Laboratory**  
[www.isi.ee.ethz.ch](http://www.isi.ee.ethz.ch)

**Laboratory for Surface Science and Technology**  
[www.surface.mat.ethz.ch](http://www.surface.mat.ethz.ch)

**Laboratory of Thermodynamics in Emerging Technologies**  
[www.ltnt.ethz.ch](http://www.ltnt.ethz.ch)

**University of Zurich, Medical Faculty**  
[www.med.unizh.ch](http://www.med.unizh.ch)

**University Hospital Zurich**  
[www.usz.ch](http://www.usz.ch)



# Prospective Students

## How to apply

Depending on the chosen track, the Master Program in Biomedical Engineering welcomes applications from students holding a Bachelor degree in such various fields as engineering, physics, mathematics, computer science, biology, chemistry, medicine or health sciences and technology from an internationally recognized university. Details on qualifying Bachelor degrees and additional requirements are published on the admission office's website:

[www.rektorat.ethz.ch/students/admission/master/prerequisites/index\\_EN](http://www.rektorat.ethz.ch/students/admission/master/prerequisites/index_EN)

Application deadlines and details on admission are given at: [www.admission.ethz.ch](http://www.admission.ethz.ch)

## Tuition and Cost of Living

The tuition fee is only 580 Swiss Francs per semester. However, students need to budget about 20,000 Swiss Francs (20,000 Euro) per year for living in Zurich (accommodation, subsistence, health insurance, etc.). A very limited number of scholarships are available for applicants with outstanding academic records. For more detail see:

[www.rektorat.ethz.ch/students/finance](http://www.rektorat.ethz.ch/students/finance)

## Continuing with Doctoral Studies?

Good master students may consider continuing their studies towards a PhD degree. PhD students are generally well paid. Applications should be made directly to a professor.

# ETH Zürich

ETH Zurich is one of the leading international universities for technology and the natural sciences. It is well-known for its excellent education, ground-breaking fundamental research and for implementing its results directly into practice. To researchers, it offers an inspiring working environment, to students, a comprehensive education.

Founded in 1855, ETH Zurich today has more than 18'000 students from over 110 countries, including 3'900 doctoral students. About 500 professors currently teach and conduct research in engineering, architecture, mathematics, natural sciences, system-oriented sciences, and management and social sciences. ETH Zurich regularly appears at the top of international rankings as one of the best universities in the world. 21 Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the university.

## Student Life

Zurich is consistently rated as one of the best places in the world to live. The city is situated on the beautiful lake of Zurich with the mountains less than an hour away. Zurich is relatively clean and safe and has an excellent public transportation system and a high standard of living. The city has an international flair and offers many cultural activities as well as a vibrant nightlife. Most Swiss are multilingual and English is often the language of choice. Although German is not required for the Master program, some knowledge will make navigating the city and the university much easier. Language courses for students are available at: [www.sprachenzentrum.uzh.ch](http://www.sprachenzentrum.uzh.ch) ETH Zurich itself offers a wide variety of sports, music, recreational and continuing education opportunities.

An overview can be found at: [www.ethz.ch/prospectives/leisure/index\\_EN](http://www.ethz.ch/prospectives/leisure/index_EN)

Brochures on every topic of life in Zurich are available in English at: [www.welcome.zh.ch](http://www.welcome.zh.ch)



## Contact

ETH Zurich

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Gloriastrasse 35  
8092 Zurich, Switzerland

[frei@biomed.ee.ethz.ch](mailto:frei@biomed.ee.ethz.ch)  
[www.master-biomed.ethz.ch](http://www.master-biomed.ethz.ch)  
[www.ethz.ch](http://www.ethz.ch)

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