


MASTER

Biomedical Engineering

A photograph of two women in a laboratory setting. They are standing on either side of a patient lying on a gurney, which is positioned inside the gantry of an MRI scanner. The woman on the left is wearing a light purple long-sleeved shirt and dark jeans. The woman on the right is wearing a red and white striped short-sleeved shirt and dark pants. The MRI machine is a large, white, cylindrical structure with a glowing yellow interior. The floor is a light blue color. The overall lighting is bright and clinical.

Master of Science ETH in Biomedical Engineering

Department of Information Technology
and Electrical Engineering

Department of Mechanical
and Process Engineering

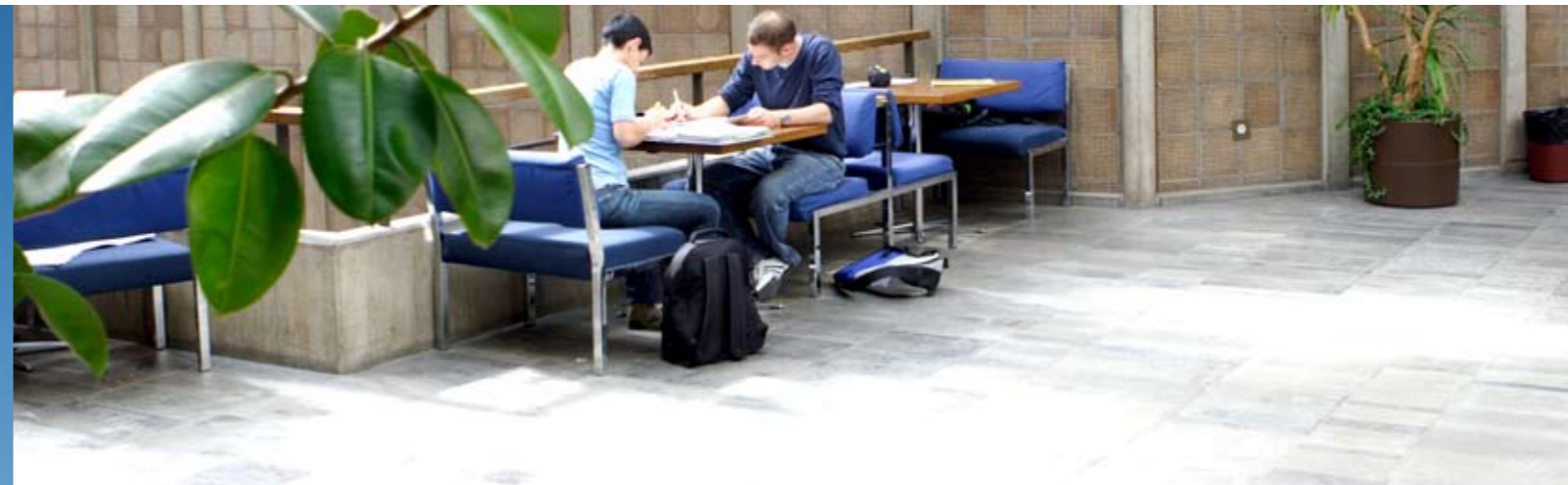
ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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 and engineering. The ETH and the University Hospital of Zurich provide a fertile ground for innovative biomedical engineering research, numerous BioTech spin-offs and several interdisciplinary academic programs. The MSc Biomedical Engineering program at the ETH Zurich draws its curricula from eight different departments and provides individually tailored training in one of four subdivisions within biomedical engineering:

- Bioelectronics
- Bioimaging
- Biomechanics
- 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 1.5-2 years to complete.

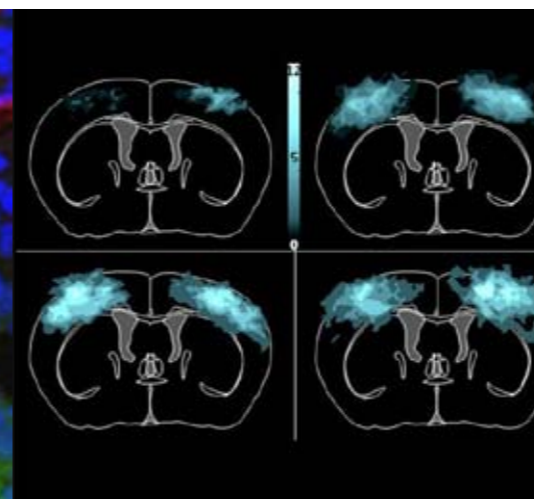
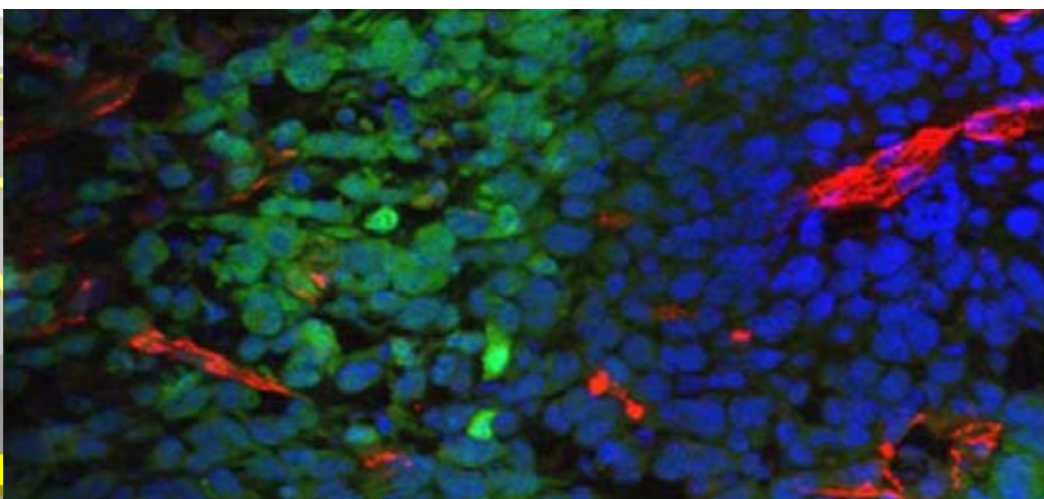
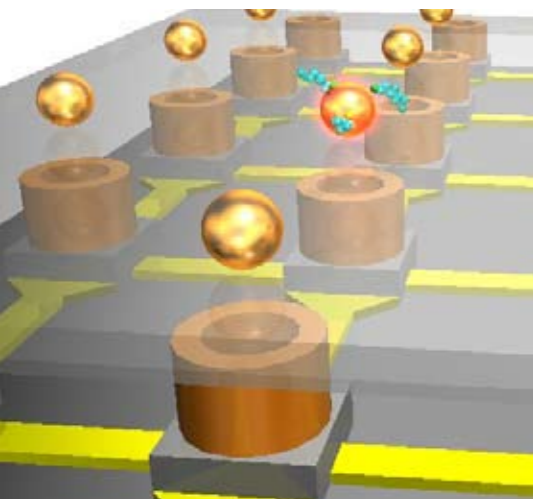
In most instances, the classroom course work is completed in the first two semesters of the program. The semester project requires a 50% work load and is generally done in the second semester of the program. The 6-month Master thesis project is started once all other requirements are completed. Topics for research projects can be found on the websites of the program-associated faculty members (page 6-7).

The four tracks or specializations within biomedical engineering are described on pages 8-11.

A track advisor who is an expert in your area is available to advise and support you in your selection of courses and research projects.

Three core biology courses have been created to give students fundamentals in cell biology, molecular biology, anatomy, physiology as well as practical laboratory techniques.

Track Courses	30 cp ECTS	Courses at the introductory and advanced level in the chosen area of specialization. A minimum of 12 cp needs to be taken from track core courses.
Biology Courses	12 cp ECTS	Cell & Molecular Biology (6 cp) and Anatomy & Physiology (6 cp) are courses designed to meet the needs of future biomedical engineers.
Bio Laboratory	6 cp ECTS	Provides practical experience in basic laboratory techniques, DNA and RNA isolation, protein isolation and identification, cell culture.
Humanities	2 cp ECTS	Courses chosen from the Department of Humanities, Social Sciences and Political Science which enrich the student's general education.
Semester Project	10 cp ECTS	The semester project gives students hands-on research experience in their chosen specialization. The project is supervised by a program-affiliated member and the topic must be approved by the track advisor.
Master Thesis	30 cp ECTS	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 supervised by a program-affiliated faculty member and the topic must be approved by the track advisor.



Associated Faculty Members

Over 30 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 websites as well as at: www.biomed.ee.ethz.ch

Professor Peter Bösiger
MRI, Functional Imaging, Brain & Cardiac Imaging
www.mr.ethz.ch

Professor Amedeo Caflich
Computational Protein Folding, Misfolding and Aggregation
www.biochem-caflisch.unizh.ch

Professor Jürg Dual
Blood Viscometry, Cell Manipulation
www.ifm.ethz.ch

Dr. Alfredo Franco-Obregon
Muscle development and mechanobiology
www.lbb.ethz.ch

Professor Martin Fussenegger
Biopharmaceutical Manufacturing, Gene Therapy & Networks
www.bsse.ethz.ch/groups/group_fussenegger/index

Professor Luigi Gallo
Dental Biomechanics
www.dent.unizh.ch/kfs

Professor Roger Gassert
Rehabilitation Engineering
www.relab.ethz.ch

Dr. Jörg Goldhahn
Orthopaedic Biomechanics
www.schulthess-klinik.ch

Dr. Heike Hall
Biomaterials, Biomimetic matrices, cell-matrix interactions
www.nanomat.mat.ethz.ch/people/staff/hheike

Professor Ari Helenius
Imaging of viral entry into cells
www.bc.biol.ethz.ch/people/groups/arih/

Professor Andreas Hierlemann
Bioelectronics, electrogenic cells, microelectronics
www.bsse.ethz.ch/bel

Professor Christofer Hierold
Biomedical Micro- and Nanosystems
www.micro.mavt.ethz.ch

Professor Dimos Poulikakos
Biofluidics, heat and mass transfer in biological systems.
www.ltnt.ethz.ch

Professor Petros Koumoutsakos
Computational modeling and simulations
www.cse-lab.ethz.ch

Dr. Ruth Kroschewski
Organogenesis in vitro, shape-polarity dependence
www.bc.biol.ethz.ch

Professor Hans-Andrea Loeliger
Signal Processing
www.isi.ee.ethz.ch

Professor Edoardo Mazza
Tissue Biomechanics
www.zfm.ethz.ch/e/biomechanics/

Professor Ralph Müller
Biomechanics, Bioimaging, Tissue Engineering
www.biomech.ethz.ch

Professor Bradley Nelson
Micro- and nanorobotics
www.iris.ethz.ch

Professor Sven Panke
Synthetic Biology, Production of Protein-based Novel Materials
www.bsse.ethz.ch/bpl

Professor Klaas Prüssmann
Bioimaging, Magnetic resonance technology and methods
www.biomed.ee.ethz.ch

Professor Robert Rieni
Neurorehabilitation, robotics, virtual reality
www.sms.mavt.ethz.ch

Professor Thomas Rösgen
Fluid Mechanics
www.ifd.mavt.ethz.ch

Professor Markus Rudin
Animal MRI, Molecular Imaging
www.biomed.ee.ethz.ch

Professor Vahid Sandoghdar
Biophotonics
www.nano-optics.ethz.ch

Professor Jess Snedeker
Orthopaedic Biomechanics
www.balgrist.ch/Home/Forschung_und_Lehre/Orthopaedie/Experimental_Research_Biomechanics/About_us.aspx

Professor Nicholas Spencer
Biotribology, biomolecule-surface interactions
www.surface.mat.ethz.ch

Professor Marco Stampanoni
X-ray microscopy
www.biomed.ee.ethz.ch/research/x-ray_microscopy

Professor Wendelin Stark
Functional Materials, Nanoparticles
www.fml.ethz.ch

Professor Andreas Stemmer
Nanotechnology, AFM, Cell Imaging
www.nano.mavt.ethz.ch

Professor Gabor Szekely
Medical Image Analysis, Visualization, Virtual Reality
www.vision.ee.ethz.ch

Professor Marcus Textor
Multifunctional polymers, Biosensors chips, Drug Carriers
www.surface.mat.ethz.ch/people/professors/textor

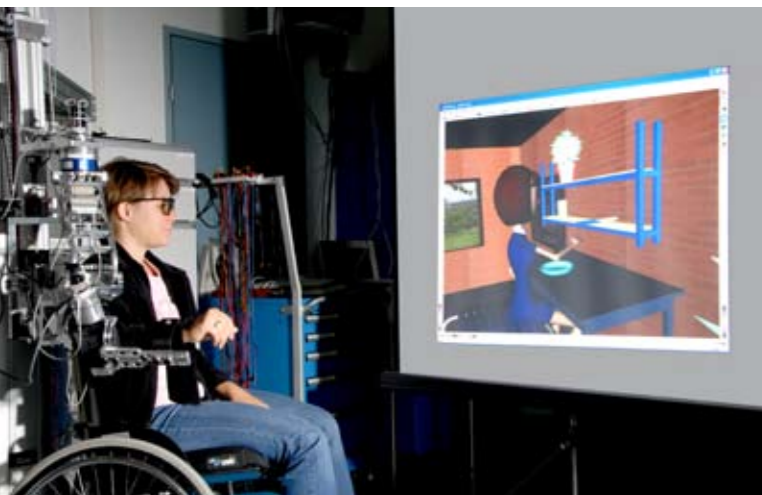
Professor Harry van Lenthe
Bone Mechanics
www.biomech.ethz.ch

Professor Viola Vogel
Tissue engineering, molecular and cellular biomechanics
www.nanomat.mat.ethz.ch

Professor Janos Vörös
Biosensors and Bioelectronics
www.lbb.ethz.ch

Dr. Martin Wolf
Biophotonic Devices
www.neuroscience.uzh.ch/research/biomedical_technology/wolf

Dr. Marcy Wong
Tissue Engineering, Cartilage Mechanobiology
www.lbb.ethz.ch



Bioelectronics

Track Advisor:

Prof. Janos Vörös
(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

Core Courses:

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

Bioimaging

Track Advisor:

Prof. Klaas Prüssmann
(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, Alzheimers disease and osteoporosis. The current course program can be found at:
www.master-biomed.ethz.ch/education/focus/Bioimaging2

Core Courses:

- Biomedical Engineering A & B
- Image Analysis and Computer Vision I
- 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
(ralph.mueller@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

Core Courses:

- Biomedical Engineering A & B
- Biomechanics III
- Biomechanics IV
- Image Analysis and Computer Vision I
- Mechanobiology
- Micro- and Nano-Tomography of Biological Tissues
- Orthopaedic Biomechanics
- Trauma Biomechanics I & II

Molecular Bioengineering

Track Advisor:

Prof. Viola Vogel
(viola.vogel@mat.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

Core Courses:

- Biostatistics
- Frontiers in Nanotechnology
- Drug Delivery and Drug Targeting
- Fundamentals of Biology IIA: Cell Biology
- Introduction to Bioinformatics: Concepts and Applications
- Measuring on the Nanometer Scale
- Mechanobiology
- Physics in Medical Research: From Humans to Cells
- Quantitative and Analytical Light Microscopy



Biology Courses

Cell and Molecular Biology for Engineers (227-0945-00L)

This course deals with the strategy of life from a mechanistic and thermodynamic perspective. The course will commence with the evolutionary milestones that gave way to higher multi-cellular organisms and will end with the integrative behaviour of specific cell types. Original scientific manuscripts will supplement the course text aimed at highlighting recent technological advances in cell biology.

Dr. Alfredo Franco-Obregon
franco@biomed.ee.ethz.ch

Anatomy & Physiology for Biomedical Engineers (227-0398-00L)

This course provides an introduction into the functions and structural properties of tissues, organs, systems of organs and the human body as an organism. The course Cell and Molecular Biology for Engineers (227-0945-00L) is a prerequisite. The main part of the course is dedicated to the most important systems of organs (respiration, heart and circulation, nervous system, digestion, secretion, skeleton and muscles, immune system, reproductive system and sensory organs). Anatomy and physiology are discussed in a thematic order. Each topic is preceded by some comments concerning evolution and/or embryology. The content of the lectures is adapted for engineers and an emphasis is placed on medical terminology. In a supplementary part of the course, a few topics in applied physiology will be presented.

Dr. Max Casty
mcasty@ethz.ch

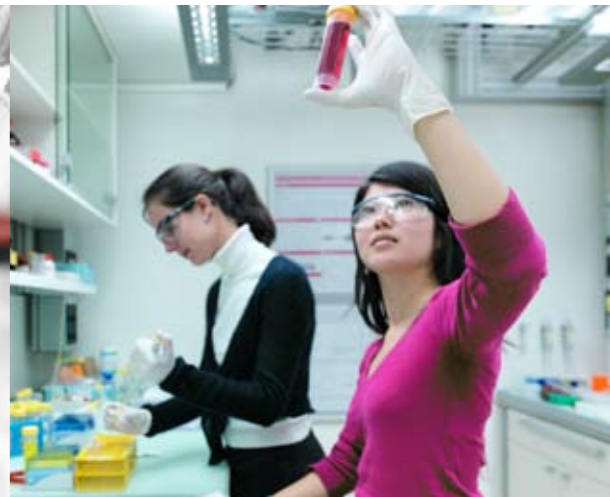
Biological Methods for Engineers (227-0949-00P)

The goal of the laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

The laboratory course will cover the following topics:

- Basic laboratory skills and safety
- Cell culture techniques
- Protein analysis
- DNA Isolation and analysis
- RNA Isolation and quantitative PCR
- Genotyping

Dr. Marcy Zenobi-Wong
zmarcy@ethz.ch



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

The 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

Brochures on every topic of life in Zurich are available in English at:
www.welcome.zh.ch

How to Apply

The Master Program in Biomedical Engineering welcomes applications from students holding a bachelors degree in engineering, physics, mathematics or computer science from an internationally recognized university. The official program language is English.

Application deadlines and details on admission are given at:
www.admission.ethz.ch

The Master program starts in fall and takes on average 1.5-2 years to complete.

The total cost of living and studying at the ETH Zurich, including tuition, is approximately 20'000 CHF/year.

Partial scholarships are available for those in financial need. More details can be obtained by contacting the Scholarship Office:
www.rektorat.ethz.ch/students/finance/index_EN



Contact

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