LIFE SCIENCES ENGINEERING
This master program offers a cross-disciplinary training for the next generation of engineer-scientists who will apply their skills and knowledge to address fundamental and applied research questions in Life Sciences Engineering.

Students may choose to deepen their knowledge in relevant Specializations. Alternatively, they may complete a Minor.
**Dissecting fat tissues one cell at a time**

Prof. Bart Deplancke

Given the striking increase in the worldwide prevalence of obesity, studying the onset of this debilitating syndrome and its physiopathology is of great interest. One key aspect of such studies is understanding the molecular mechanisms that mediate adipocyte formation and adipose tissue plasticity. However, and as surprising as this may sound, our knowledge of the developmental origin of adipocytes is still very limited. In a recent study, we mapped the gene expression profiles of thousands of individual adipose stromal cells from which fat cells are thought to arise. Using high-level, bioinformatic analyses, we uncovered several distinct subpopulations among those stromal cells, clearly pointing to important cellular heterogeneity. Interestingly but also unexpectedly, we found that one of these subpopulations is not only refractory to fat cell differentiation, but also exhibits a remarkable capacity to inhibit in vitro and in vivo mammalian adipocyte formation. Consequently, we decided to name this novel cell type, Aregs, for Adipogenesis Regulators. This finding is of great biomedical interest, not only because it provides new insights into how the plasticity of fat depots may be regulated, but also potentially into how often undesired adipocyte accumulation in other systems such as the muscle and bone marrow could be controlled.

**Bioengineering long-lived ‘mini-gut’ tubes**

Prof. Matthias Lutolf

Tissue and organ biology are very challenging to study in mammals, and progress can be hindered, particularly in humans, by sample accessibility and ethical concerns. However, advances in stem cell culture have made it possible to derive in vitro miniature tissues called ‘organoids’, which capture some of the key multicellular, anatomical and even functional hallmarks of real organs. Current organoid technologies however invariably result in tissues with a closed, cystic architecture that restricts lifespan and size and limits experimental manipulation.

In a recent study, we have engineered bioartificial hydrogel scaffolds, providing cell-adhesive interactions and gut-shaped 3D micro-topography, as a template for extrinsically guiding intestinal stem cell (ISC) development into open, tubular ‘mini-guts’. Owing to the in vivo-like anatomical scaffold structure, ISCs undergo a stereotypical cell-fate patterning process that results in an in vivo-like spatial arrangement of crypt/villus domains. Tubular mini-guts retain key physiological hallmarks of native intestine, such as the digestive function of enterocytes and the secretion of mucus by goblet cells, and they readily support the growth of microbiota. This concept for extrinsically guiding stem cell self-organization processes can be broadly applicable for existing epithelial organoids to attain more physiologically relevant sizes, shapes and functions.
Master of Science in
LIFE SCIENCES ENGINEERING
2-year program - 120 ECTS

Core courses 15 ECTS
Scientific Thinking 5 ECTS
Law, organization and economics 3 ECTS
Industrial internship 8 ECTS

Options 53 ECTS

Students may choose a 30 ECTS specialization:
A) Biomechanical engineering
B) Biomedical engineering
C) Biophotonics and bioimaging
D) Cellular and molecular engineering
E) Computational biology
F) Nanoscale bioengineering
G) Neuroscience and neuroengineering

Or opt for a 30 ECTS minor included in the 120 ECTS.
Minors recommended with this Master:
- Biocomputing
- Biomedical technologies
- Biotechnologies
- Computational neurosciences
- Management, technology, entrepreneurship
- Neuroprosthetics

Core courses

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<tr>
<th>Specializations</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
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<tr>
<td>Applied biostatistics</td>
<td>A</td>
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<tr>
<td>Applied data analysis</td>
<td>A</td>
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<tr>
<td>Applied probability and stochastic processes</td>
<td>E</td>
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<tr>
<td>Biomedical signal processing</td>
<td>B</td>
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<tr>
<td>Biomechanics I, II</td>
<td>A</td>
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<tr>
<td>Dynamical system theory for engineers</td>
<td>C</td>
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<tr>
<td>Fundamentals of biomedical imaging</td>
<td>C</td>
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<tr>
<td>Image processing I</td>
<td>A</td>
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<tr>
<td>Image processing II</td>
<td>C</td>
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<tr>
<td>Machine learning</td>
<td>C</td>
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<tr>
<td>Numerical methods in biomechanics</td>
<td>A</td>
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<td>Understanding statistics and experimental design</td>
<td>A</td>
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Scientific thinking 5 ECTS
Scientific literature analysis in:
- Bioengineering 5
- Computational molecular biology 5
- Neuroscience 5

Scientific project design in:
- Cell and developmental biology 5
- Drug discovery 5
- Integrative neurosciences 5
- Synthetic biology (GCB) 5
- Translational neurosciences 5
- Translational oncology 5

Law, organization and economics 3 ECTS

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<tr>
<td>A</td>
<td>B</td>
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<tr>
<td>Economics of innovation and IP</td>
<td>3</td>
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<td>Innovation management</td>
<td>3</td>
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<tr>
<td>Introduction au droit et à l'éthique</td>
<td>3</td>
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<tr>
<td>Principles of finance</td>
<td>3</td>
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</tbody>
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Options 53 ECTS

Advanced bioengineering methods laboratory | A | B | C | D | E | F | 4 |
Analog circuits for biochip | B | C | D | E | F | 3 |
Analysis and modeling of locomotion | A | B | 4 |
Artificial neural networks | A | C | D | F | 5 |
Bioimage informatics | C | E | 4 |
Biological modeling of neural networks | A | B | C | F | 4 |
Biomaterials | A | B | C | F | 4 |
Biomechanics of the cardiovascular system | A | B | 3 |
Biomechanics of the musculoskeletal system | A | B | 5 |
Biomedical optics | C | 3 |
BioMEMS | B | C | F | 2 |
Biomolecular structure and mechanics | A | C | 4 |
Biophysics: physics of the cell | A | C | D | F | 3 |
Biophysics: physics of biological systems | A | C | F | 4 |
Cancer biology I, II | D | 10 |
Computational cell biology | D | E | 4 |
Computational motor control | A | E | G | 4 |
Controlling behavior in animals and robots | A | E | G | 4 |
Deep learning | E | 4 |
Flexible bioelectronics | B | F | G | 4 |
Fracture mechanics | A | B | 3 |
Frontiers in chemical biology | C | D | F | 3 |
Fundamentals of biophotonics | C | F | 3 |
Fundamentals of biosensors and electronic biosignals | B | C | F | 3 |
Fundamentals of microfabrication | B | C | F | 3 |
Fundamentals of neuroengineering | B | C | D | F | 4 |
Genomics and bioinformatics | D | E | 4 |
Hydrodynamics | A | C | F | 4 |
Image analysis and pattern recognition | B | 3 |
Imaging optics | B | F | G | 4 |
Immunoeengineering | D | F | 4 |
Immunology | D | 5 |
Infection biology | D | 5 |
In silico neuroscience | E | F | 4 |
Interfaces in biology and nanoscience | C | F | 4 |
Lab immersion I, II | 16 |
Lab immersion III (semester project) | 12 |
Lab immersion academic (outside EPFL) | 22 |
Lab immersion in industry | 22 |
Lab methods: animal experimentation | A | B | D | G | 2 |
Lab methods: bioactive compounds screening | A | B | D | F | 2 |
Lab methods: flow cytometry | D | 2 |
Lab methods: histology | B | D | G | 2 |
Lab methods: proteomics | B | D | 2 |
Micro-nano-robots | A | 3 |
Modèles stochastiques pour les communications | E | 6 |
Molecular endocrinology | D | 4 |
Nanomaterials | B | C | F | 3 |
Nanobiotechnology and biophysics | A | B | F | 3 |
Neuroscience for engineers | B | 4 |
Neuroengineering of vision | B | 4 |
Neuroscience: from molecular mechanisms to disease | D | G | 5 |
Neuroscience: cellular and circuit mechanisms | D | G | 5 |
Neuroscience: behavior and cognition | G | 5 |
New tools & research strategies in personalized health | B | D | 4 |
Numerical methods in biomechanics | A | 3 |
Nutrition: from molecules to health | D | 4 |
Pharmacology and pharmacokinetics | B | D | 4 |
Principles and applications of systems biology | D | E | 3 |
Randomness and information in biological data | D | E | 3 |
Seminar in physiology and instrumentation | A | B | F | 2 |
Sensorimotor neuroprosthetics | A | B | G | 4 |
Sensors in medical instrumentation | B | C | F | 3 |
Signal processing for functional brain imaging | C | E | G | 3 |
Single cell biology | D | 4 |
Statistical physics of biomacromolecules | A | 4 |
Stem cell biology and technology | B | D | 3 |
Structural mechanics | A | B | 4 |
Synthetic biology | D | E | 4 |
Tissue engineering | B | D | 4 |