ME-480

# Mechanobiology: how mechanics regulate life

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| Cursus | Sem. | Type |
|---|---|---|
| Biomedical technologies minor | H | Opt. |
| Life Sciences Engineering | MA1, MA3 | Opt. |
| Mechanical engineering minor | H | Opt. |
| Mechanical engineering | MA1, MA3 | Opt. |
| Minor in life sciences engineering | H | Opt. |
| Physics of living systems minor | H | Opt. |

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| Contact language | English |
| Credits | 3 |
| Withdrawal | Unauthorized |
| Session | Winter |
| Semester | Fall |
| Exam | During the semester |
| Workload | 90h |
| Weeks | 14 |
| **Hours** | **3 weekly** |
| Lecture | 2 weekly |
| Exercises | 1 weekly |
| **Number of positions** | |

## Summary

The objective of this course is to expose students to the fundamentals of mechanobiology. We will highlight the technologies that enable the study of living systems including mechanical manipulation and characterization, along with computational modeling frameworks.

## Content

The course will cover the micro/nanoscale physics, biological mechanosensors and actuators, motility, extracellular matrix mechanics, tissue and cell mechanics, morphogenesis, and control issues. After providing the basic background, we will explore the current trends in the literature, discuss select case studies, and develop conceptual novel solutions for outstanding issues. The course will be divided into the following sections:

- Mechanobiology of microbes and biofilms.
- Mechanobiology during infections
- Mechanobiology of plant cells and tissues
- Fundamentals of mechanotransduction (cytoskeleton, nucleus, and signaling)
- Mechanobiology of immune cells and tumors
- Mechanobiology of morphogenesis and regeneration
- Synthetic morphogenesis and biomimetic culture systems

## Keywords

mechanosensing, mechanotransduction, physics of living systems, solid mechanics, fluid mechanics, bioinstrumentation, quantitative microscopy, microtechnology, robotic biomanipulation.

## Learning Prerequisites

### Recommended courses

Biomaterials (BIOENG-442)
Physics of Cells (BIO-244)

## Learning Outcomes

By the end of the course, the student must be able to:

- Propose mechanical tests for the characterization of biological tissues and fluids, B6
- Describe the feedback loop that, starting from a mechanical signal translated into a chemical signal, allows for the adaptation of the mechanical properties of tissues, B9
- Develop physical models of living systems
- Synthesize learned engineering skills to create novel solutions, CP14
- Specify the role of mechanics in a particular physiological or pathological process

## Transversal skills

- Make an oral presentation.
- Summarize an article or a technical report.
- Write a scientific or technical report.
- Access and evaluate appropriate sources of information.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.

## Teaching methods

- Ex cathedra
- Interactive presentations of case studies by graduate students
- Exercises
- Student Presentations

## Expected student activities

- Active participation
- Reading background literature
- Critical evaluation of technical articles and group presentations
- Writing a report

## Assessment methods

- Literature Review Report (25%)
- Assignments (25%)
- Final Project (50%)

## Supervision

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| Office hours | No |
| Assistants | Yes |
| Forum | Yes |

## Resources

### Bibliography

- Physical Biology of the Cell, by Rob Philipps and collegaues. Garland Science (2nd edition).
- Mechanisms of Morphogenesis, by Jamie A. Davies. Academic Press (2nd edition).
- Biological Physics of the Developing Embryo by Gabor Forgacs and Stuart A. Newman. Cambridge

University Press.

### Ressources en bibliothèque

- Mechanisms of Morphogenesis, by Jamie A. Davies
- Physical Biology of the Cell, by Rob Philipps
- Biological Physics of the Developing Embryo by Gabor Forgacs and Stuart A. Newman

### Moodle Link

- https://go.epfl.ch/ME-480