Microfluidic Horizons 2026

Exploring Frontiers in Physical
Chemical & Biomedical Sciences

Pre-Conference Short Courses

May 16 - 17, Padova, Italy

www.microfluidics2026.it

Aims, Scopes, Logistics

When?

The Microfluidic Horizons 2026 conference is preceded by a **two-day** series of Short Courses on **16 and 17 May 2026**.

Where?

Please notice, that the Short Courses will take place in the rooms of the Department of Physics and Astronomy "G. Galilei", University of Padua, This is a **different location** respect to the main Conference Venue.

Who?

The Short Courses will cover the principles of microfluidic technology and its application to the life sciences. Designed **primarily for PhD students and postdoctoral researchers**, the courses aim to build a solid conceptual and practical foundation before engaging in the MH26 conference.

What?

Through a combination of **lectures and live demonstrations**, participants will gain hands-on insight into the design and execution of microfluidic experiments, while also exploring key techniques in cell biology and biomedicine.

Lecture Streams

The Short Courses are organized in two parallel sessions:

1. **Microfluidics in Room Rostagni** starting on **16 May 2026 at 2:30 pm**.
2. **Biotechnology in Room B** starting on **16 May 2026 at 2:30 pm**.

Short Courses Agenda

Day	Time	Microfluidic Track (Room Rostagni - DFA)	Biotechnology Track (Room B - DFA)
Sat 16th	14.30 - 16.00	**M1 -** Fluid mechanics at the micro & nanoscales. *Dr. Eleonora Secchi (ETH Zurich)*	**B1 -** Principles of cell structure. Prof. Paola Brun (University of Padua) *Dr. Mahmoud Elsayed Mosaad Shalata (University of Padua)*
	16.00-16.15	Break	
	16.15-17.45	**M2 -** Microfabrication: From design to device. *Dr. Davide Ferraro (University of Padua)*	**B2.1 -** Interacting with living matter. *Dr. Carlo Rigoni (Institute of Science and Technology Austria - ISTA)* **B2.2 -** Beyond the genetic code. *Dr. Alessandra Giannella (University of Padua)*
Sun 17th	9.00-10.30	**M3 -** Flow control strategies at the microscale (micro-plumbing). *Dr. Eleonora Secchi (ETH Zurich) & Dr. Stefano Ugolini (ETH Zurich)*	**B3.1 -** Microsystems designed to probe the mechanical properties of cellular systems. *Dr. Gianluca Grenci (Mechanobiology Institute; Biomedical Engineering Department - NUS)* **B3.2 -** Magnetic Nanoparticle Platforms in Biomedicine: From Alzheimer's Diagnostics to Stem Cell Engineering. *Dr. Alessandro Surpi (Institute for Nanostructured Materials - CNR Bologna)*
	10.30-10.45	Break	
	10.45-12.15	**M4 -** Controlling microenvironments: On-chip and off-chip approaches. *Dr. Stefano Ugolini (ETH Zurich) & Dr. Eleonora Secchi (ETH Zurich)*	**B4.1 -** Engineering cell biology. *Dr. Massimo Bellato (University of Padua)* **B4.2 -** Cell communication: biology, pathways, and mechanisms. *Dr. Mahmoud Elsayed Mosaad Shalata (University of Padua)*
	12.15-13.45	Lunch	
	13.45-15.15	**M5 -** Readout strategies in microfluidics. *Prof. Filippo Menolascina (University of Edinburgh) & Prof. Roberto Rusconi (Humanitas University of Milan)*	**B5 -** Microfluidics in clinical practice. *Prof. Marco Scarpa (University of Padua)* *Prof. Ignazio Castagliuolo (University of Padua)*
	15.15-15.30	Break	
	15.30-17.00	**M6 -** Computational Fluid Dynamics & Numerical Tools in Microfluidics. *Prof. Mirko Gallo (University of Rome 'La Sapienza')*	**B6 -** Engineering biology at the microscale: concepts, design, and applications. *Dr. Giulia Turlon (University of Padua)*
	17.15-18.15	Plenary Lecture & Kick off of Microfluidic Horizons 2026 - **Room Rostagni DFA** Viscoelasticity as a Control Parameter in Microfluidic Flows *Prof. Pier Luca Maffettone (University of Naples)*	
	19.00	Welcome Buffet (San Gaetano Convention Centre)	

Microfluidics Stream

Lecture M1 - Fluid mechanics at the micro/nanoscales
16 May 2026 | 2:30 pm | Room Rostagni

Dr. Eleonora Secchi (ETH Zurich)

In this lecture, we will present the fundamental principles of fluid mechanics at the micro- and nanoscales those governing the behavior of liquids in microfluidic systems where surface forces dominate over inertia.
We will discuss the key differences between microscale flows and conventional fluid dynamics, including low Reynolds number regimes, mixing characteristics, and the critical role of interfacial phenomena. Finally, we will explore applications in microfluidics, highlighting how these principles enable precise control of transport processes.

Lecture M2 - Microfabrication: From design to device
16 May 2026 | 4:15 pm | Room Rostagni

Dr. Davide Ferraro (University of Padua)

This lecture provides an overview of microfabrication, the set of techniques that enable the creation of microscale structures and devices.
We will cover the entire process from design principles and material selection to fabrication methods such as photolithography, soft lithography, and etching. Emphasis will be placed on how these techniques translate concepts into functional devices for applications in microfluidics.

Lecture M3 - Flow control strategies at the microscale
17 May 2026 | 9:00 am | Room Rostagni

Dr. Eleonora Secchi (ETH Zurich) & Dr. Stefano Ugolini (ETH Zurich)

Precise flow control is essential for the functionality of microfluidic systems, where miniaturization introduces unique challenges and opportunities.
This lecture will cover the main strategies for controlling fluid flow at the microscale, discussing the principles behind these methods, their advantages and limitations, and how they can be combined for complex operations.
Finally, we will look at practical examples and connectors such as tubing, fittings, and interface solutions that enable reliable integration of these strategies into real-world microfluidic devices.

Microfluidics Stream

Lecture M4 - Controlling microenvironments: On-chip and off-chip approaches
17 May 2026 | 9:00 am | Room Rostagni

Dr. Stefano Ugolini (ETH Zurich) & Dr. Eleonora Secchi (ETH Zurich)

Microfluidic systems rely on precise control of their microenvironment to ensure reproducibility and functionality. This lecture will explore strategies for controlling key parameters such as temperature, gas composition, and electric fields both on-chip and off-chip. We will discuss the underlying principles and practical implementation, including connectors and interface solutions that enable reliable coupling between chips and external systems.
Real-world examples will illustrate how these approaches support applications in diagnostics, biophysics, chemistry, and material science.

Lecture M5 - Readout strategies in microfluidics
17 May 2026 | 1:45 pm | Room Rostagni

Prof. Filippo Menolascina (University of Edinburgh)
& Prof. Roberto Rusconi (Humanitas University of Milan)

Accurate and efficient readouts are essential for extracting meaningful data from microfluidic systems. This lecture will cover the main strategies for detecting and analyzing outputs, including imaging techniques, chemical and biochemical assays, and integrated sensor technologies. We will discuss the principles behind these approaches, their advantages and limitations, and how to select the right method for specific applications. Practical examples will illustrate how readout strategies are implemented in diagnostics, biophysics, chemistry, and material science.

Lecture M6 - Numerical approaches in microfluidics
17 May 2026 | 1:45 pm | Room Rostagni

Prof. Mirko Gallo (University of Rome “La Sapienza”)

Modeling microfluidic flows is challenging due to viscous, interfacial, and non-continuum effects. This lecture first reviews numerical frameworks, discussing their strengths and limits across regimes. The second part focuses on meso-scale methods for micro-and nano-fluidics, bridging molecular and continuum scales. These approaches integrate thermal fluctuations and thermodynamics to study phase changes, stochastic diffusion, and non-equilibrium phenomena.

Biotechnology Stream

Lecture B1 - Principles of cell structure
16 May 2026 | 2:30 pm | Room B

Prof. Paola Brun (University of Padua) &
Dr. Mahmoud Elsayed Mosaad Shalata (University of Padua)

Cells exhibit a broad diversity of external structures, ranging from lipid membranes and cell walls in eukaryotic cells and yeasts to capsules, envelopes, and protein coats in bacteria and viruses. This lecture introduces the structural organization of prokaryotic and eukaryotic cell surfaces and their interactions with the extracellular matrix under physiological conditions. Emphasis is placed on how the surface architecture and composition regulate cell adhesion, viability, growth, and replication. These concepts provide the biological foundation for understanding how cells respond to external cues.

Lecture B2.1 - Interacting with living matter
16 May 2026 | 4:15 pm | Room B

Dr. Carlo Rigoni (Institute of Science and Technology, Austria)

Cell envelopes are electrically active structures defined by surface charges, mem brane potentials, and ion gradients. This lecture will explore how we can interact with cells and bacteria by using physical stimuli. We will present how confinement, chemical gradients, light, magnetic and electric fields can be used to control the motion and modify the behavior of living matter and how this bridges to microfluidics techniques.

Lecture B2.2 - Beyond the genetic code
16 May 2026 | 5:00 pm | Room B

Dr. Alessandra Giannella (University of Padua)

Even sharing the same genome, cells can exhibit strikingly different phenotypes depending on how genes are regulated. This lecture introduces the main epigene tic mechanisms, including chromatin remodeling, DNA methylation, and histone modifications, that control gene accessibility and expression. We examine how environmental cues and external stimuli modulate transcriptional programs and protein processing. Emphasis is placed on understanding epigenetic regulation as a dynamic process. These concepts are essential for interpreting cellular responses under physiological conditions and in confined and engineered microfluidic environments.

Biotechnology Stream

Lecture B3.1 - Microsystems designed to probe the mechanical properties of cellular systems

17 May 2026 | 9:00 am | Room B

Dr. Gianluca Grenci (Mechanobiology Institute, Singapore)

Cells dynamically sense and respond to the mechanical properties of their environ ment, including stiffness, confinement, tension, and fluid-induced shear stress. This lecture explains how extracellular mechanical forces are detected at the cell surface. We introduce the main mechanotransduction pathways and describe their impact on cytoskeletal remodeling and cell fate decisions. Microfluidic platforms are powerful tools for controlling mechanical cues using imaging tools.

Lecture B3.2 - Magnetic Nanoparticle Platforms in Biomedicine: From Alzheimer's Diagnostics to Stem Cell Engineering

17 May 2026 | 9:45 am | Room B

Dr. Alessandro Surpi (CNR Bologna)

Magnetic particles are widely used in clinical research, but current systems rely on relatively large micrometer-sized beads. The use of ultrasmall nanoparticles — comparable to biological molecules—can be highly beneficial, but their control is hindered by thermal fluctuations. We present a magnetic approach that enables reliable manipulation of <20 nm nanoparticles. This technology supports highly sensitive detection of Alzheimer's disease biomarkers and controlled delivery of neural morphogens to stem cells. These advances offer new tools for early diagnosis and emerging regenerative therapies.

Biotechnology Stream

Lecture B4.1 - Engineering cell biology
17 May 2026 | 10:45 am | Room B

Dr. Massimo Bellato (University of Padua)

Synthetic biology provides a systematic platform for designing and reprogramming cellular functions. This lecture introduces the fundamental strategies for genetic manipulation, including gene cloning, genome editing, and the construction of genetic circuits, inducible systems, and engineered feedback loops. Synthetic biology in microfluidics enables precise control over cellular environments, prediction of perturbations, and selection of single traits within a cellular population. Applications range from biosensing and signal processing to programmed cellular behaviors. Emphasis is placed on data-driven approaches for quantifying responses and inferring functional relationships in complex biological systems.

Lecture B4.2 - Cell communication: biology, pathways, and mechanisms
17 May 2026 | 11:30 am | Room B, DFA

Dr. Mahmoud Elsayed Mosaad Shalata (University of Padua)

This lecture will explore how chemical signals transform a collection of distinct cells into a single, functional living organism. We examine the science of signal transduction, which examines how cells use particular proteins and chemical chains to convert external stimuli into distinct internal actions. We will learn how cells maintain their organization and make the crucial decisions necessary for survival by investigating various forms of communication, from local exchanges to body-wide signals

Biotechnology Stream

Lecture B5 - Microfluidics in clinical practice
17 May 2026 | 1:45 pm | Room B, DFA

Prof. Marco Scarpa (University of Padua)
Prof. Ignazio Castagliuolo (University of Padua)

Despite their strong potential, microfluidic technologies still face significant barriers to clinical adoption. This lecture examines the main challenges in translating microfluidic platforms from the laboratory to real clinical settings, including robustness, reproducibility, standardization, regulatory constraints, and biological variability. Through selected case studies -such as liquid biopsies, antimicrobial susceptibility testing, and the detection of emerging or rare pathogens we highlight both successful and unsuccessful translation attempts. Particular attention is given to clinically relevant biological complexities, including dormant bacterial states, genetic versus phenotypic antibiotic resistance, and the limitations of current diagnostic assays for screening and disease staging.

Lecture B6 - Engineering biology at the microscale: concepts, design, and applications
17 May 2026 | 3:30 pm | Room B

Dr. Giulia Turlon (University of Padua)

Focusing on the intersection of microfluidics and biotechnology, this course introduces the key concepts needed to design and interpret microfluidic experiments for controlled biological studies. It gives an overview of microfluidic device fabrication, including soft lithography, followed by diffusion-driven processes and gradient generation. Building on these elements, the course highlights how microfluidics enables precise and reproducible control of cellular microenvironments through the integration of engineering and biology. The session combines theoretical insights with live demonstrations to bridge concepts and practical applications in complex biological systems.

Plenary Lecture

Viscoelasticity as a Control Parameter in Microfluidic Flows
17 May 2026 | 5:00 pm | Room Rostagni

Prof. Pier Luca Maffettone (University of Naples)

In recent years, microfluidics has emerged as a powerful tool for a wide range of applications in biotechnology and medicine. Among the various techniques developed, viscoelastic microfluidics has gained significant attention due to its ability to manipulate particles and cells in a simple and efficient manner. By exploiting the non-Newtonian properties of the suspending medium, viscoelastic microfluidics enables precise control over particle motion, even at low Reynolds numbers.
This lecture will provide an overview of the fundamental principles and recent advances in viscoelastic microfluidics, with a focus on: **size-dependent particle migration** in straight and curved microchannels; **sheathless particle focusing in complex geometries**; the role of **fluid elasticity in enhancing particle separation** and sorting; the **effect of channel cross-section and flow rate** on the focusing performance.
The practical implications of these phenomena will be discussed, highlighting their potential for high-throughput cell sorting, rare cell detection, and point-of-care diagnostics. Finally, the challenges and future perspectives of viscoelastic microfluidics will be addressed, emphasizing the need for a deeper understanding of the underlying physics and the development of robust and scalable microfluidic platforms.

Contacts

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More information at

microfluidics2026.it/short-courses

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