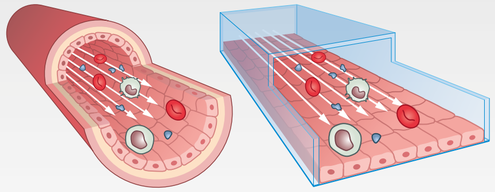
Cell Culture Under Flow

Enhancing Cellular Physiology and Function Through Dynamic Microenvironments

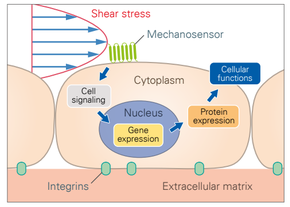
cells in focus ibidi®



Traditional static cell culture techniques fail to mimic the dynamic nature of *in-vivo* environments, limiting the physiological relevance of the experimental results. At ibidi, we focus on developing solutions that enable researchers to cultivate and investigate cells under *in vivo*-like conditions.

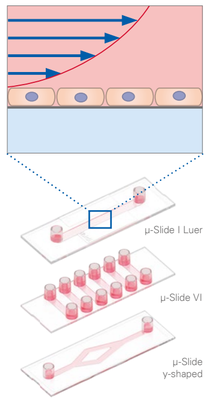
Here, we provide a comprehensive overview of the features and applications of the ibidi Pump System in combination with specialized channel slides. These slides are designed to stimulate the mechanical force generated by fluid flow, such as wall shear stress in blood and lymphatic vessels. They also support the long-term cultivation of both 2D and 3D cells by enhancing cellular viability and perforation through optimal nutrient supply and waste removal functioning as perfusion-based 3D bioreactors.

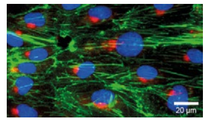
Wall Shear Stress



- Simulation of mechanical forces (shear stress) created by fluid flow in biofluidic systems (e.g., blood or lymphatic vessels, nephrons)
- Physiological long-term cultivation of vascular endothelial and epithelial cells
- Analysis of relevant readouts, such as cell morphology, behavior, and physiology

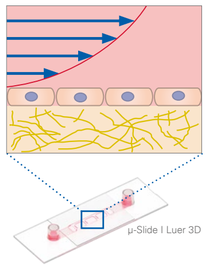
Cell monolayer on coverslip

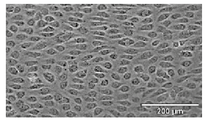




HUVECs were cultured under flow at 10 dyn/cm² for 4 days in a µ-Slide I 0.4 Luer ibiTreat. Human-Golgin-97 (red), F-actin (green), and nuclei (blue).

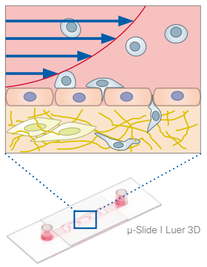
Cell monolayer on gel matrix

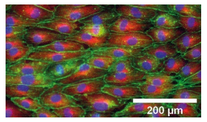




Phase contrast microscopy of HUVEC cultivated under flow at 10 dyn/cm² for 5 days on Collagen I

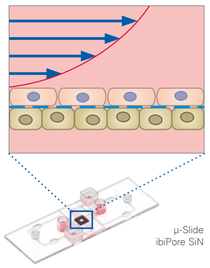
Cell monolayer on gel matrix: cells in flow / inside gel matrix

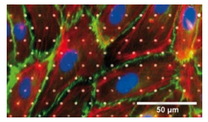




IF staining of HUVEC after culturing them under flow at 10 dyn/cm² for 5 days on Collagen I; alpha-tubulin (red), F-actin (green), nuclei (blue)

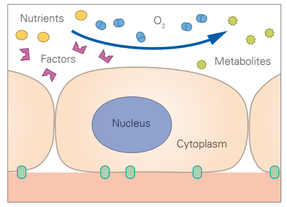
Co-culture cell monolayers on optical porous membrane



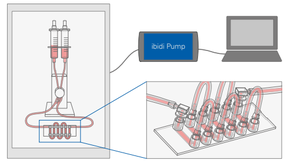


IF staining of human endothelial cells in the µ-Slide ibiPore coated with Collagen. Overlay image of phase contrast, DAPI (blue), VE-cadherin (green), and F actin (red)

Perfusion-Based 3D Bioreactor

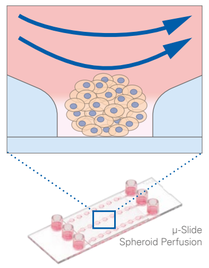


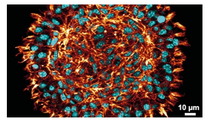
- Physiological long-term 2D and 3D cell culture (e.g., of organoids, spheroids, organs-on-a-chip)
- Continuous medium exchange for constant nutrient supply
- Ensured optimal cell viability and health



Set-up example: Graphical depiction of the ibidi Pump System connected to the ibidi µ-Slide VI 0.4

3D spheroids / organoids in confined well geometry

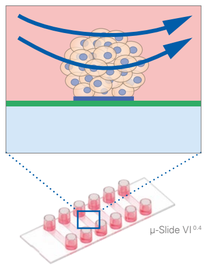


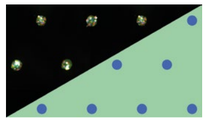


Confocal image of a cleared and stained L929 spheroid. Actin (red), nuclei (cyan) in the µ-Slide Spheroid Perfusion.

Data by J. Hofmann & S.J. Keppler, TUM, Germany.

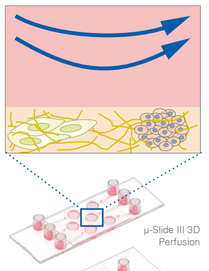
3D spheroids / organoids on micropatterned surface

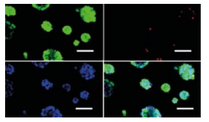




IF staining of RCC-26 (human renal carcinoma) cells cultured in the µ-Slide VI 0.4 With Multi-Cell µ-Pattern

3D cell culture inside gel matrix

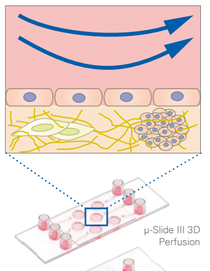


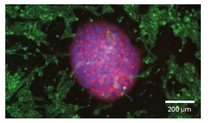


IF staining of HepG3 spheroids in a HA-PEG hydrogel in the µ-Slide III 3D Perfusion; viable cells (green), dead cells (red) nuclei (blue).

Data from Christoffersson et al 2019 Biofabrication 11 015013; BY CC 3.0 license

Co-culture of cells/ spheroids on and in gel matrix

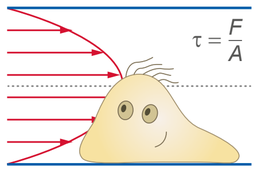




IF staining of a co-culture of MCF-7 spheroids and HUVECs in the µ-Slide I Luer; actin (red), nuclei (blue); CD31 (HUVEC marker, green)

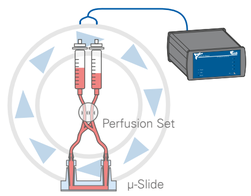
The ibidi Pump System

Defined Shear Stress



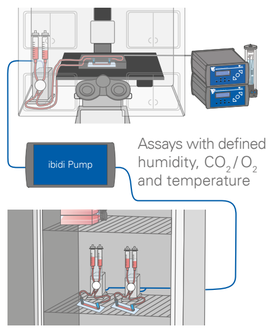
- Software-based flow programming including shear stress and shear rate calculation
- Simulation of all physiological flow patterns with a wide shear stress range (0.1–200 dyn/cm²)

Closed System

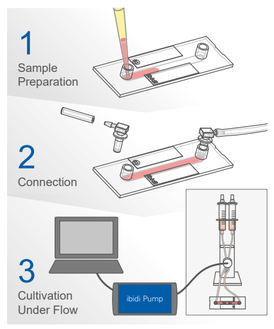


- Long-term sterile setup
- Recirculating medium at low volumes
- No medium contact with mechanical parts

Physiological Conditions

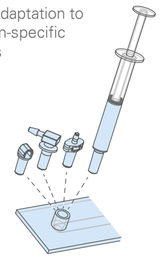


Easy Workflow

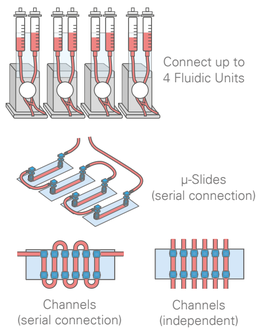


Standard Luer Ports

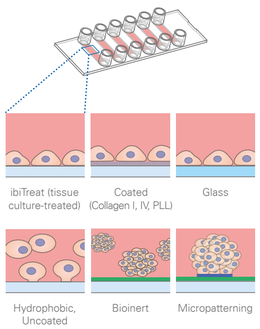
- Plug-and-play connection
- No microfluidic knowledge necessary
- Easy adaptation to custom-specific setups



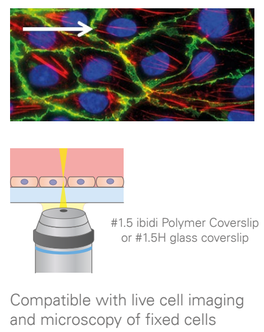
Parallelization



Flow Chamber Surfaces



Microscopy Readout



Compatible with live cell imaging and microscopy of fixed cells