



## Cell Culture Under Flow

### Using the ibidi Pump System

#### ✓ Simulate Physiologic Conditions

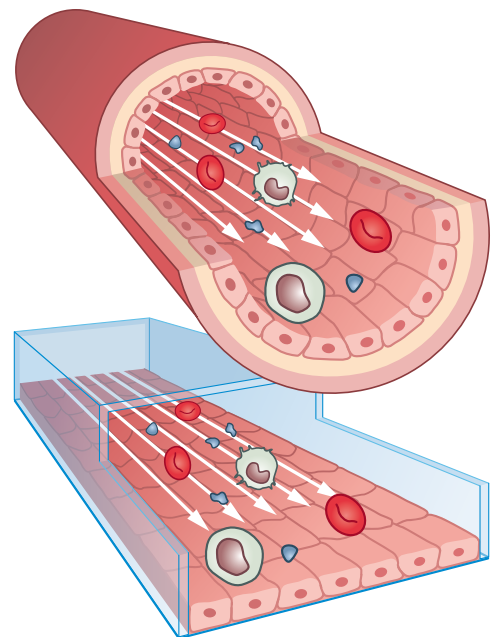
Mimic *in vivo*-like conditions for cells that are physiologically exposed to shear stress (e.g., endothelial and epithelial cells)

#### ✓ Perform Long-Term Flow

Establish cell culture under defined flow conditions for days to several weeks

#### ✓ Stay Flexible

Compatible with various cell culture slides (not limited to ibidi slides), all incubators, and incubated microscopes



#### User Comments

"We've been working with the ibidi Pump System and Labware for over 5 years now and have recommended it to numerous colleagues as well. The ibidi Pump System in fact made the endothelial cell under flow the default of our lab!"

*Dr. Nynke van den Akker, Maastricht University, The Netherlands*

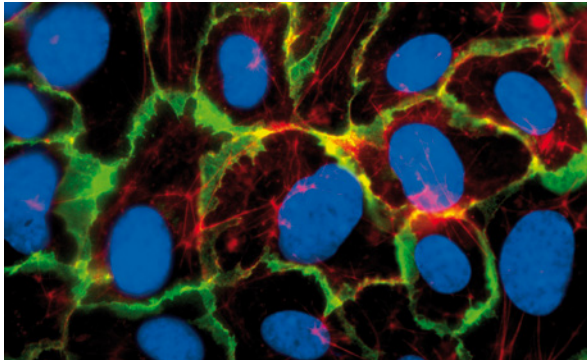
"The system has allowed us to easily investigate physiological shear patterns *in vitro* without a background in engineering."

*Shane R. McSweeney, King's College London, United Kingdom*

# The Impact of Flow and Shear Stress on Cells

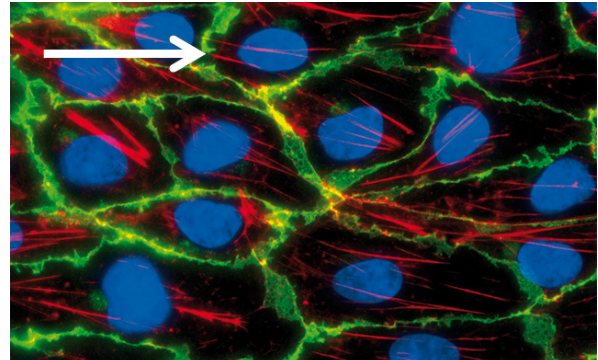
Many cell types are surrounded by moving fluids, such as vascular and lymphatic endothelial cells or epithelial cells of the kidney and the lung. This liquid flow causes shear stress, a mechanical force that has a great impact on the physiological behavior and adhesion properties of cells. Cultivating cells under flow *in vitro* enables studying endothelial and epithelial cells in a more physiological, *in vivo*-like environment.

## Static Culture



Static culture of HUVEC, 0 dyn/cm<sup>2</sup>, 5 days,  $\mu$ -Dish<sup>35 mm</sup>, ibiTreat. Red: F-actin, green: VE-cadherin.

## Flow Culture



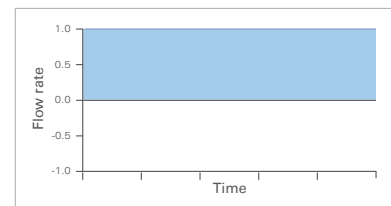
Flow-conditioned culture of HUVEC, 10 dyn/cm<sup>2</sup>, 5 days,  $\mu$ -Slide I<sup>0.4</sup> Luer, ibiTreat. Red: F-actin, green: VE-cadherin.

## Types of Laminar Flow

Laminar flow is defined as the movement of liquids without turbulence. The fluid flows in parallel layers with no disruption between them. These types of flow can be achieved using the ibidi Pump System in combination with the ibidi Channel Slides.

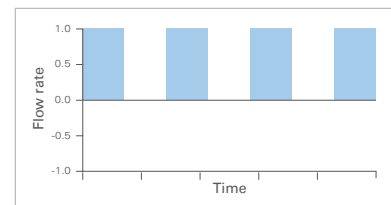
### Unidirectional Laminar Flow

- Found in most small healthy biological vessels, such as small arteries and veins
- **Experimental Setup:** Constant flow direction and flow rate



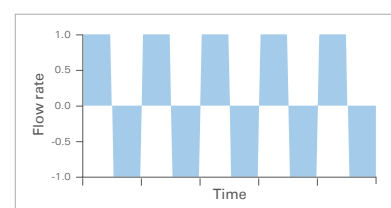
### Pulsatile Laminar Flow

- Occurring in large arterial vessels due to the fluctuations caused by the heartbeat
- **Experimental Setup:** Constant flow direction with periodically changing flow rate

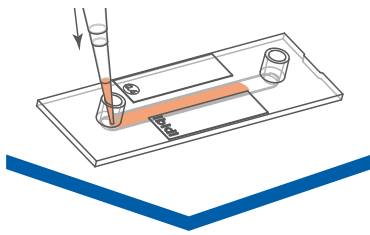


### Oscillatory Laminar Flow

- A means of simulating turbulence to mimic pathophysiological processes *in vitro*
- **Experimental Setup:** Changing flow direction at regular intervals and constant flow rate (except during valve switching)

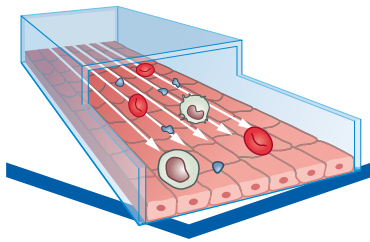


# Experimental Workflow of a Flow Assay



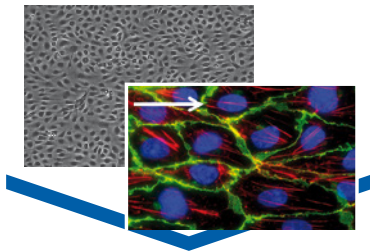
## Cell Seeding Into Channel Slides

Setup your flow assay of choice and choose from our broad portfolio of channel slides.



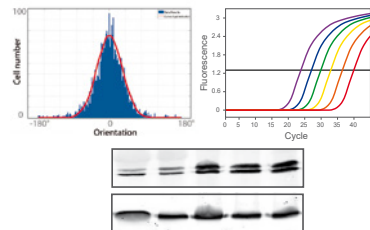
## Flow Conditioning of Adherent Cells

Apply unidirectional, oscillatory, or pulsatile flow with the ibidi Pump System.



## Staining and Image Acquisition

Image and stain cells directly in the channel slide.

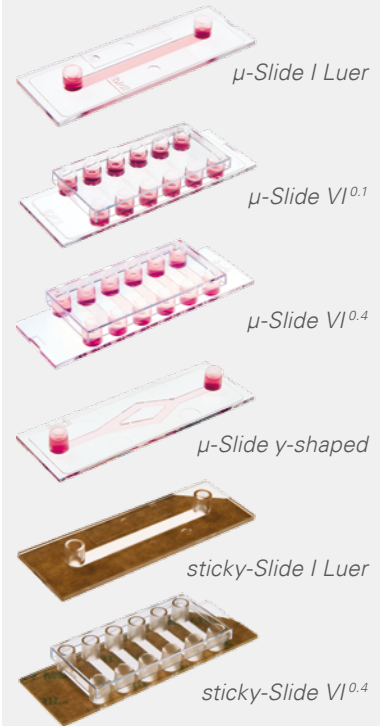


## Downstream Analysis

Easily analyze your cells with, for example, Western Blot, qRT-PCR, or FACS.

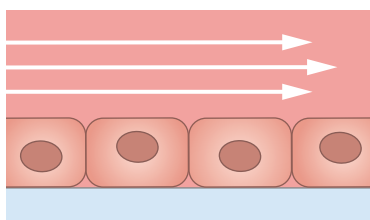
## Excellent Optical Properties

ibidi offers Channel Slides with a variety of heights and coatings for different shear stress ranges:



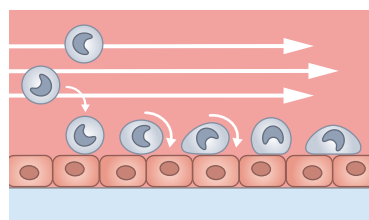
Free Samples at:  
[ibidi.com/free-samples](http://ibidi.com/free-samples)

## Experimental Examples



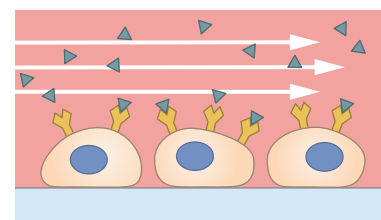
### Cells Under Shear Stress

Defined shear stress in long-term cell culture (e.g., endothelium, kidney, or biofilm)



### Rolling and Adhesion Assays

Rolling and adhesion of suspended cells (e.g., T cells) on substrates

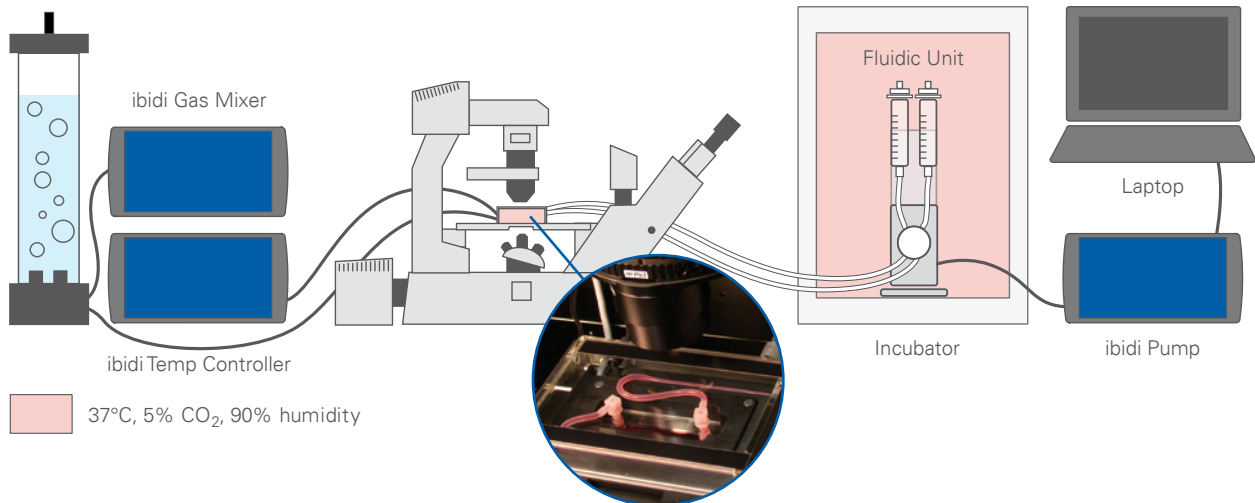


### Defined Liquid Exchange

Defined exchange of medium and supplements over time

# The ibidi Pump System

## Live Cell Imaging Setup: ibidi Stage Top Incubation System\* and ibidi Pump System



### Technical Details

- Application of unidirectional, pulsatile, and oscillating flow for simulating turbulent flow
- Long-term cell cultivation with proven cell survival for days to several weeks
- Software-calculated, defined shear stress
- Wide range of flow rates (ca. 0.1–40 ml/min) and shear stress (ca. 0.3–150 dyn/cm<sup>2</sup>)\*\*
- High throughput possible: supports up to four parallel Fluidic Units per ibidi Pump

\* *ibidi Stage Top Incubation Systems enable long-term live cell imaging; see Application Note 14: Live Cell Imaging Under Flow*

\*\* *depending on the used Perfusion Set and channel*



The ibidi Pump System is a perfusion system to cultivate cells under flow.

**Request your free demo at: [demo@ibidi.de](mailto:demo@ibidi.de)**

### Selected Publications Using the ibidi Pump System

J. Mack, T. S. Mosqueiro, B.J. Archer, et al. NOTCH1 is a mechanosensor in adult arteries. *Nature Communications*, **2017**, 10.1038/s41467-017-01741-8

J. Xu, J. Mathur, E. Vessières, et al. GPR68 Senses Flow and Is Essential for Vascular Physiology. *Cell*, **2018**, 10.1016/j.cell.2018.03.076, 0092-8674

T. Keeley, R. Siow, R. Jacob and G. Mann. A PP2A-mediated feedback mechanism controls Ca<sup>2+</sup>-dependent NO synthesis under physiological oxygen. *The FASEB Journal*, **2017**, 10.1096/fj.201700211R

A. Sabine, E. Bovay, C.S. Demir, et al. FOXC2 and fluid shear stress stabilize postnatal lymphatic vasculature. *The Journal of Clinical Investigation*, **2015**, 10.1172/JCI80454