cells in focus ibidi®

# Cell-Based Perfusion Assays

## Using the ibidi Pump System

✓ **Ideal simulation of all physiological conditions**

Continuous unidirectional, oscillating, and pulsatile flow

✓ **Fully integrated solution, also for microscopy**

Compatible with ibidi Heating Systems, all incubators, and incubated microscopes

✓ **Complete setup under sterile circular conditions**

Minimal mechanical stress, minimal amount of medium and supplement

## Applications:

- Defined shear stress, in long-term cell culture (e.g. endothelium, kidney, or biofilm)
- Live cell imaging and immunofluorescence for analyzing shear stress response
- Mimicking shear stress conditions in microcapillary, venous, and arterial flow
- Rolling and adhesion of suspended cells on substrates

### Equipment for researchers working with cell-based perfusion assays:

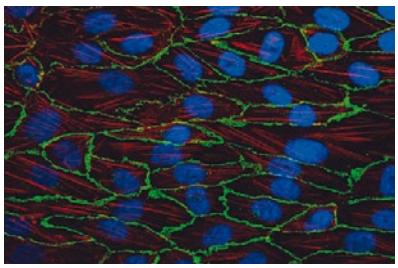
*ibidi Pump System*

*µ-Slide I Luer*

*µ-Slide VI$^{0.4}$*

*µ-Slide y-shaped*

*ibidi Heating & Incubation System*



*Human umbilical vein endothelial cells (HUVEC) cultured under flow conditions in µ-Slide I$^{0.4}$ Luer*

*blue: nucleus (DAPI)*

*green: VE-catherins (Alexa 488 conjugated antibody)*

*red: actin cytoskeleton (Cy5 conjugated antibody)*

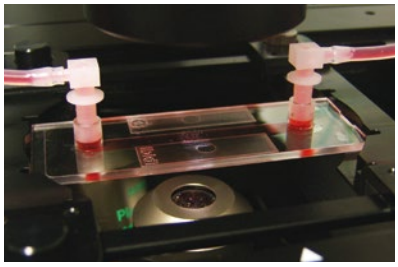
*(Courtesy S. Zahler, Munich, Germany)*

## Cultivation Under Flow Conditions

*In vivo*, several adherent cell types are exposed to mechanical shear stress, equal to what is found in blood vessels. This mechanical stimulus has a great impact on the physiological behavior and adhesion properties of cells. Cultivation of endothelial cells, under perfusion, reflects their natural environment far better than doing so under static conditions.

## ibidi µ-Slides for Easy Flow Applications in a Channel

ibidi consumables can be used in static and perfusion cell cultures. Many of the µ-Slides were especially designed to perform flow assays. Additionally, their optical quality makes them compatible with any inverted microscope technique. They are ideal for performing perfusion assays directly on the microscope, or inside the incubator.



## The ibidi Perfusion System Perfectly Reflects the Natural Environment of Cells Under Flow Conditions

The ibidi Pump System consists of two main components: The **ibidi Pump** (a computer controlled air pump) and the **Fluidic Unit** (two cell media reservoirs, with slide holder and tubes). By using this "split" approach, the closed flow setup can be assembled separately and transferred to the microscope after cell cultivation, without compromising the sterility of the system. The open architecture with the Luer connectors allows the use of any kind of flow devices. The **PumpControl software** controls the pressure, and subsequently the shear stress acting on the cells. The system is a fully integrated solution. By hosting the Fluidic Unit in the incubator, it is still possible to run perfusion assays directly on the microscope.

## Technical Details

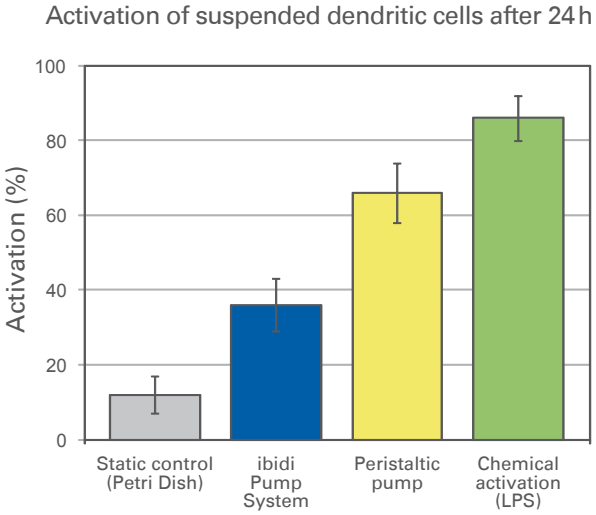
- Up to four parallel Fluidic Units per ibidi Pump
- Flow characteristics: unidirectional and continuous flow, oscillating flow for simulating turbulent flow, and pulsatile flow
- Flow rate: 0.03 – 35 ml/min
- Shear stress: 0.3 – 150 dyn/cm$^2$
- Working volume: 2.5/12 ml
- Suitable for all µ-Slides with Luer adapters
- Compatible with all incubators
- Software-controlled flow rates and shear stress

# Cell-Based Perfusion Assays

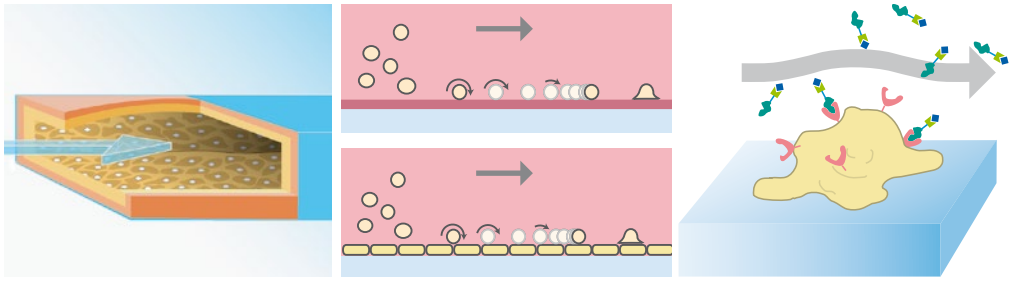
Using the ibidi Pump System

## ibidi Pump System Generates Minimal Mechanical Stress

The graph shows the degree of activation of suspended dendritic cells, in different pump systems, under identical flow rate and shear stress. In peristaltic pumps, tubes and suspended cells are mechanically squeezed. This technique leads to increased nonspecific activation of cells. The ibidi Pump System works with air pressure and reduces mechanical stress to a minimum. The nonspecific activation of suspension cells is suppressed.




## Types of Assays



| | Cells Under Shear Stress | Adhesion Assays | Stop Flow Experiments |
|---|---|---|---|
| Application | Endothelial cells under flow:<br>• Influence of shear stress on endothelial cells<br>• Preparing cells while mimicking *in vivo* perfusion conditions<br>• Formation of plaques on endothelium<br>• Biofilm formation of microorganisms<br>• Antibody stainings | Blood cells to protein surfaces:<br>• Rolling and adhesion of suspended cells such as platelets, leukocytes, monocytes on substrates, such as adhesion proteins or confluent cell monolayers | Defined liquid exchange:<br>• Defined medium exchange for optimal feeding<br>• Online drug delivery<br>• Live stainings<br>• $Ca^{2+}$-imaging |
| Recommended Pumps | • ibidi Pump System | • ibidi Pump System<br>• Syringe pumps<br>• Peristaltic pump | • Manual liquid delivery<br>• Syringe pumps<br>• Peristaltic pump |
| Duration | Hours, up to several weeks | Minutes to hours | Minutes to hours |
| Experimental Environment | Incubation conditions | Room temperature or incubation conditions | Room temperature or incubation conditions |

# Cell-Based Perfusion Assays

## Using the ibidi Pump System

## Ordering Information

### ibidi Pump System

| | |
|---|---|
| 10902 | **ibidi Pump System:** ibidi Pump, Fluidic Unit, Perfusion Set, notebook, PumpControl software |
| 10906 | **ibidi Pump System Quad:** ibidi Pump, Fluidic Unit Quad, 2 x Perfusion Set, notebook, PumpControl software |
| 10903 | **Fluidic Unit:** switching valves for various flow assays, suitable for all Perfusion Sets and Channel µ-Slides, stable aluminum housing, exchangeable reservoir holders |
| 10904 | **Fluidic Unit Quad:** 4 Fluidic Units on a stable plate, switching valves for various flow assays, suitable for all Perfusion Sets and channel µ-Slides, stable aluminum housing |
| 10905 | **ibidi Pump:** accuracy: +/- 1 mbar, pressure range: -100 to +100 mbar, control for up to 4 Fluidic Units, including Pump Control software |
| 10908 | **Notebook:** ready to use, pre-configured Windows system, PumpControl software |

### Accessories for ibidi Pump System

| | |
|---|---|
| 10961 | **Perfusion Set BLUE:** 15 cm, ID 0.8 mm, 10 ml (3 units) |
| 10962 | **Perfusion Set RED:** 15 cm, ID 1.6 mm, 10 ml (3 units) |
| 10963 | **Perfusion Set WHITE:** 50 cm, ID 0.8 mm, 10 ml (3 units) |
| 10964 | **Perfusion Set YELLOW/GREEN:** 50 cm, ID 1.6 mm, 10 ml (3 units) |
| 10965 | **Perfusion Set YELLOW:** 15 cm, ID 0.5 mm, 2 ml (3 units) |
| 10966 | **Perfusion Set BLACK:** 50 cm, ID 0.5 mm, 2 ml (3 units) |
| 10971 | **Filter/Reservoir Set, 10 ml:** sterile (10 units) |
| 10972 | **Filter/Reservoir Set, 2 ml:** sterile (10 units) |
| 10974 | **Filter/Reservoir Set, 50 ml:** sterile (10 units) |

The ibidi Pump System is optimized for use with all ibidi channel slides. For detailed ordering information on the whole line of ibidi µ-Slides, please go to: **www.ibidi.com**.

## Selected Publications Using the ibidi Pump System:


T. Keeley *et al.* A PP2A-mediated feedback mechanism controls Ca2+-dependent NO synthesis under physiological oxygen. The FASEB Journal, 2017.

W.W Sugden *et al.* Endoglin controls blood vessel diameter through endothelial cell shape changes in response to haemodynamic cues. Nature Cell Biology, 2017.

R. de Bruin *et al.* The RNA-binding protein quaking maintains endothelial barrier function and affects VE-cadherin and ß-catenin protein expression. Scientific Reports, 2016.

H. Kwon *et al.* *In vivo* modulation of endothelial polarization by Apelin receptor signalling. Nature Communications, 2016.

A. Sabine *et al.* FOXC2 and fluid shear stress stabilize postnatal lymphatic vasculature. The Journal of Clinical Investigation, 2015.

T. G. Walsh *et al.* Stabilization of Brain Microvascular Endothelial Barrier Function by Shear Stress Involves VE cadherin Signaling Leading to Modulation of pTyr Occludin Levels. Journal of Cellular Physiology, 2011.



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