**Supporting Information**

**1. Chemical distribution in the upper channel**

We confirmed that the chemical gradient in the upper channel could be formed and kept stably. In this experiment, we injected FITC solution and water at 2 μL/min each to form a laminar flow pattern in the lower channel after filling the upper channel with FITC solution. And fluorescence images of the FITC distribution were taken every 60 seconds by a confocal laser scanning microscope (Fig.S1). At 0s, FITC were distributed homogenously and gradually forming a specific distribution with time. Even starting from the condition that the whole upper channel is filled with FITC solution, the steady-state chemical gradient can be formed within 120 seconds by the transport from the laminar flow formed in the lower channel. This proves that the gradient pattern of FITC at 120s has already reached at its steady state, meaning that there is no accumulation of FITC in the upper channel. Thus, the chemical distribution in the upper channel can stably be maintained for a long term.

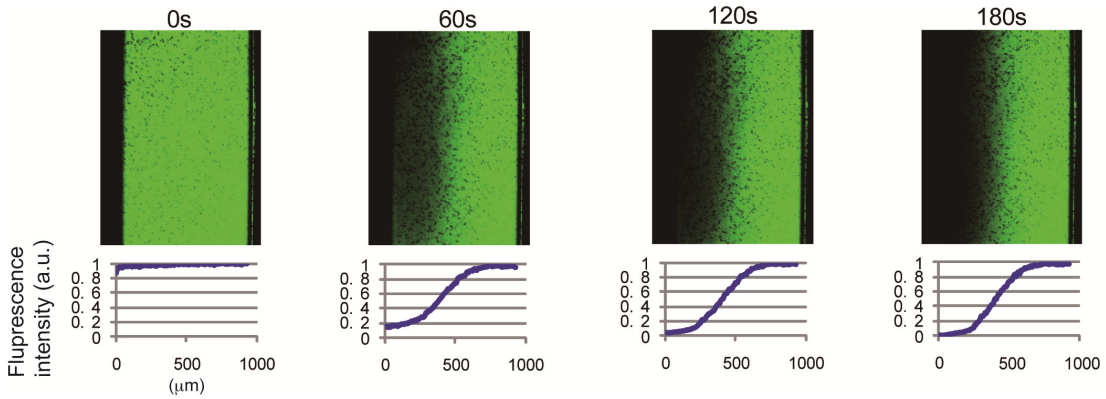


Figure S1 FITC distribution in the upper channel. FITC images taken every 60 seconds and the plots of their FI distribution. FI signal was normalized by the maximum value measured across the lateral axis of the channel.

**2. Flow velocity in the upper channel**

We measured the flow velocities in the lower and upper channels by tracking fluorescent beads. Suspension of fluorescent beads (diameter: 1μm) in PBS were injected into the device from an inlet of the lower channel, and the moving speed of the beads around the measurement line indicated in Fig.4E was calculated by measuring their travelling distances. The measurements were carried out for two different flow rates 2 and 4 μL/min with and without miPSCs seeded on the membrane in the device, i.e., in the upper channel. The ratios of flow velocities in the upper and lower channels (flow velocity in the upper channel / flow velocity in the lower channel) were calculated and plotted as shown in Fig.S2. When there are no cells, the ratios are 0.271 and 0.213 for the flow rates 2 and 4 μL/min, respectively. On the other hand, when there are cells on the membrane, the ratios are 0.0904 and 0.0903, respectively. The values with cells are much lower than those with no cells. It can be speculated to be due to the blockage of the pores by the cells seeded on the membrane.

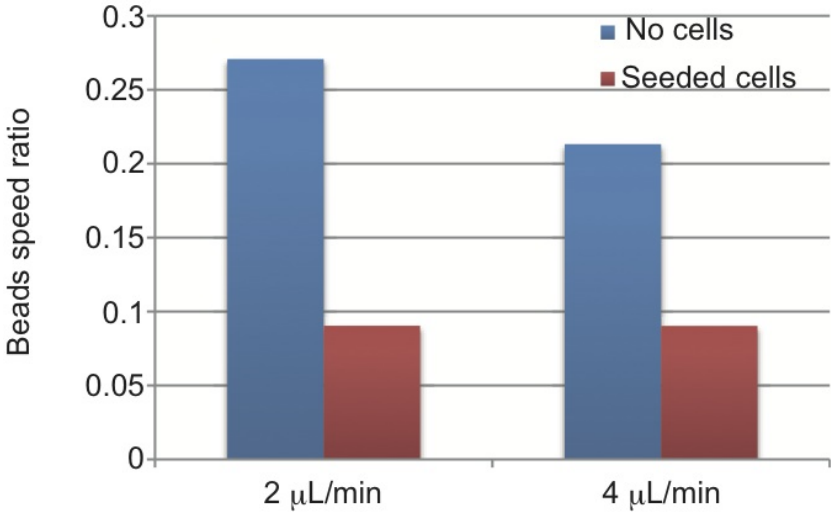


Figure S2 Ratio between flow velocities in the upper and lower channels. Blue bars show the ratios with no cells, whereas red bars show the rations with seeded cells, both at the flow rates of 2 and 4 μL/min

**3. Cells on the Membrane**

We observed the cells on the membrane during the medium injection at 4 μL/min (Fig.S3). Observable changes in cellular morphology were not found even after 2 hours. This indicates that the flow through the pores does not make significant effects on the cells attachment and morphology for a short term.

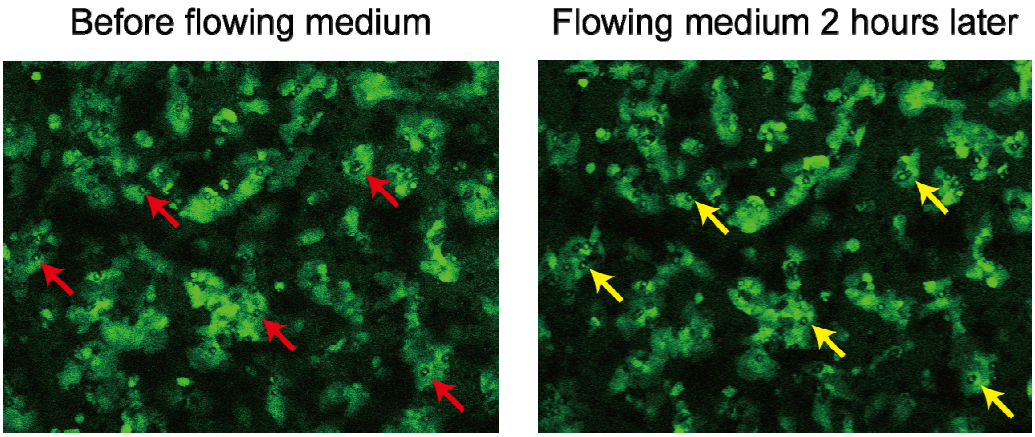


Figure S3 Observation of miPSCs cultured on the membrane. Arrows indicate cellular colonies on pores before and after 2 hours of medium injection at 4 μL/min.