Organ-on-a-Chip System

Introduction

Organ-on-a-Chip (OOC) technology provides a novel in vitro platform with possibility of reproducing physiological functions of in-vivo tissue, more accurately than conventional cell-based model systems. The technology opens up great opportunities for next-generation experiments of mimicking human organ functionality, microphysiology and morphology in vitro, replacing traditional animal-based model systems.

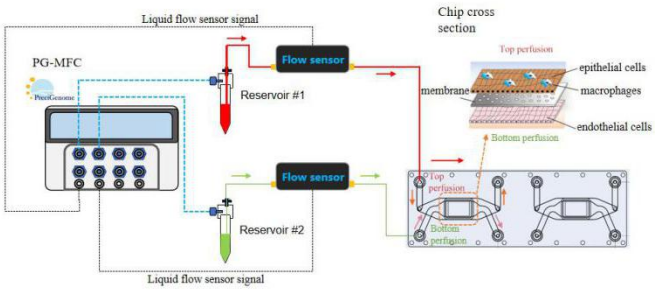
PreciGenome offers customizable Organ-on-a-Chip system, which is able to recreate dynamic in-vivo conditions for modeling biochemical and biophysical features of cells' native environment. Combining the PG-MFC controller and microfluidic membrane chips, the system provides multi-channel perfusion or reagent recirculation capability to ensure cell nurturing over days/weeks.

System Benefits

- Controlled shear stress
- Long duration experiments
- Automation
- Controllable pressure and flow rates
- Ready to connect with an incubator
- Open platform
- Temperature control module is also available for integration into a custom system

System Option #1: Multi-Media Culture System

The system is comprised of PG-MFC controller, two microfluidic reservoir kits, two liquid flow sensors (optional), an Organ-on-a-Chip membrane chip (or a custom-made chip), and accessories such as tubing, fittings, and connectors. Pressures precisely generated by PG-MFC controller push the culture media in the reservoir kits into the Organ-on-a-Chip. The liquid flow sensors can be optionally connected in the flow path for flow rate monitoring and control.

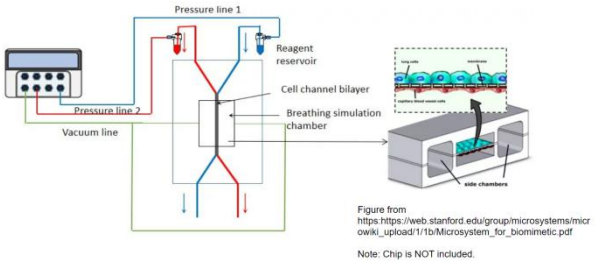


System Content:

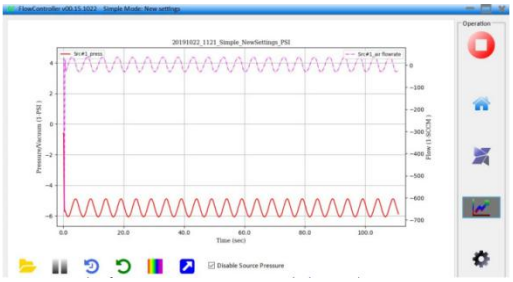
- PG-MFC controller, 1 pc (light version is compatible)
- Reservoir kits (15mL, 50ml or 1.5ml tube), 2 sets
- Organ-on-a-Chip (OOC) membrane chip, 1pc (optional)
- Liquid flow sensor (optional)
- Tubing and fittings, 1 set

Setup example: Lung-on-a-Chip

In this Lung-on-a-Chip case, two pressure and one vacuum sources are used, which connect to different inlets of a chip. Two pressure lines push different reagents into the chip to mimic blood flow into lung and exchange chemicals through cell channel bilayer as shown in the Figure below. The vacuum line connects to the side chamber to simulate the breathing process in a lung.



A schematic of Lung-on-a-Chip system

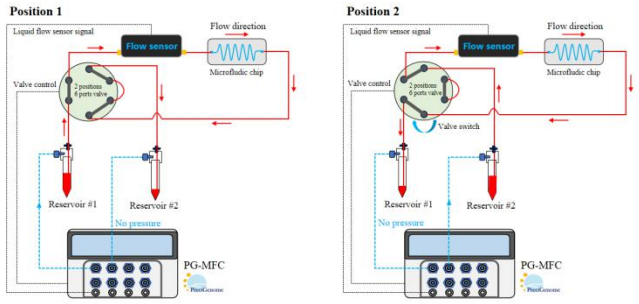


Sine wave output of the vacuum line with air flow monitoring

System Option #2: Media Recirculation System

Media recirculation system uses a given volume of culture medium and recirculates the medium throughout the perfusion flow. By using the same culture medium, the molecules secreted by the cells are kept in the same culture flow.

The recirculation system is comprised of a PG-MFC controller, a 6-port switching valve, two microfluidic reservoir kits, an Organ-on-a-Chip, a liquid flow sensor (optional), and other accessories such as tubing, fittings, and connectors. By switching the positions of the 2 position/6-port switching valve, a unidirectional flow inside the Organ-on-a-Chip can be achieved.



A schematic of media recirculation system

A media recirculation system setup

System Content:

- PG-MFC controller, 1 pc (light version is compatible)
- 6-port switching valve, 1 pc
- Reservoir kits (15mL, 50ml or 1.5ml), 2 sets
- OOC membrane chip, 1pc (optional)
- 3-way valves, 2 pcs (only for light version controller)
- Liquid flow sensor (optional)
- Tubings and fittings, 1set

Microfluidic OOC Chips

The microfluidic OOC chips contain two cavities, each comprising an integrated membrane serving as cell culture area. Cells cultured on the membrane are perfusable independently from both the apical or basal side through upward directed (upper perfusion) and downward directed (lower perfusion) channels. The chips have two in- and outlet ports above and below the membrane.

The chip is made by injection molding from polystyrene (PS) or Topas. A 12 µm thick polyethylene terephthalate (PET) membrane with a pore diameter of 8 µm or 0.2 um and a pore density of 1×10e5 pores/cm² was integrated in the upper and lower part of the chip by heat-sealing with the bulk material. This allows for organ-on-a-chip experiments such as small molecule transfer measurements, on-chip dialysis or cell culture experiments.

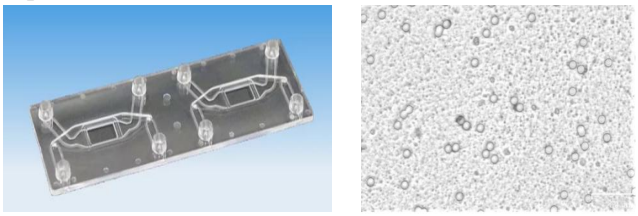
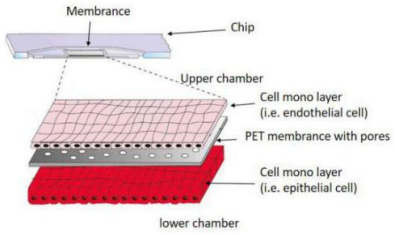


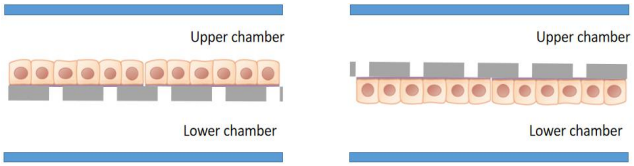
Image of the OOC membrane chip and porous PET membrane layer of the chip



Culture Modes and Applications

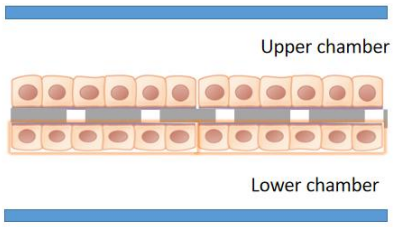
Mode #1: Single-sided Culture

A cell monolayer is cultivated on one side of the membrane in the chip.



Mode #2: Double-sided Culture

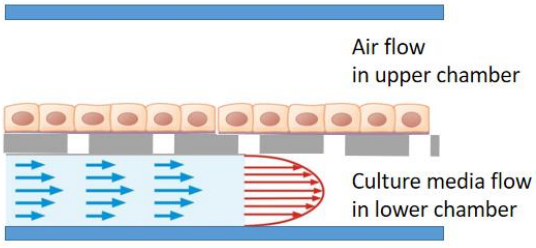
Two cell monolayers, one layer on the top of membrane and another layer beneath the membrane, are cultivated simultaneously in the chip. Molecules are transferable through the pores on the membrane. Thus, this culture mode is fit for cell studies such as signaling, co-culture, and transport studies.



Applications

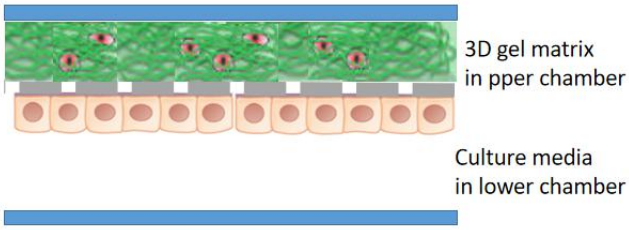
Skin-on-a-Chip Model

Skin models with air-liquid interface are a good fit for this culture mode. Skin-on-a-Chip is used for test of topical pharmaceuticals and cosmetics, studying the pathology of skin diseases and inflammation. Also it is to test for the presence of antigens or antibodies which could denote the presence of a pathogen. The model in the Figure below shows a polarized skin cell monolayer is cultured on one side of the membrane with cells exposed to air in the upper chamber. The flow of culture medium goes through the lower chamber.



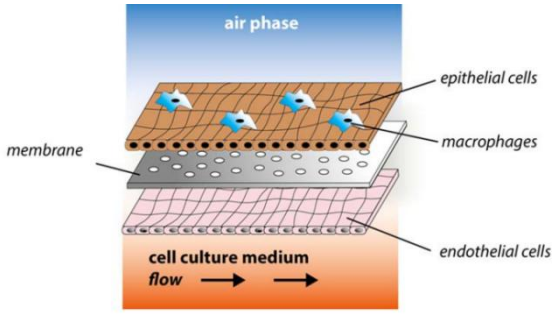
Apical-Basal Cell Polarity Assay Model

A cell monolayer is cultivated at one side of the membrane. On the other side, a 3D gel matrix fills the chamber. In some applications cells are embedded in the 3D gel matrix. Chemical factors inside the 3D gel matrix lead to the polarization of a cell monolayer at the opposite side of the 3D gel matrix.



Lung-on-a-Chip Model

The Lung-on-a-Chip is a complex, three-dimensional model of a live and breathing human lung on a microchip. The device is made using human lung and blood vessel cells and it can predict absorption of airborne nanoparticles and mimic the inflammatory response triggered by microbial pathogens. Lung-on-a-Chip is being designed in an effort to improve the physiological relevance of existing in vitro alveolar-capillary interface models. Such a multifunctional microdevice can reproduce key structural, functional and mechanical properties of the human alveolar-capillary interface.



www.precigenome.com/organ-on-a-chip-system