Micro physiological systems for *ex vivo* tissue culture

Fraunhofer Institute for Material and Beam Technology IWS

Focus on prolonged tissue viability and parallel online monitoring

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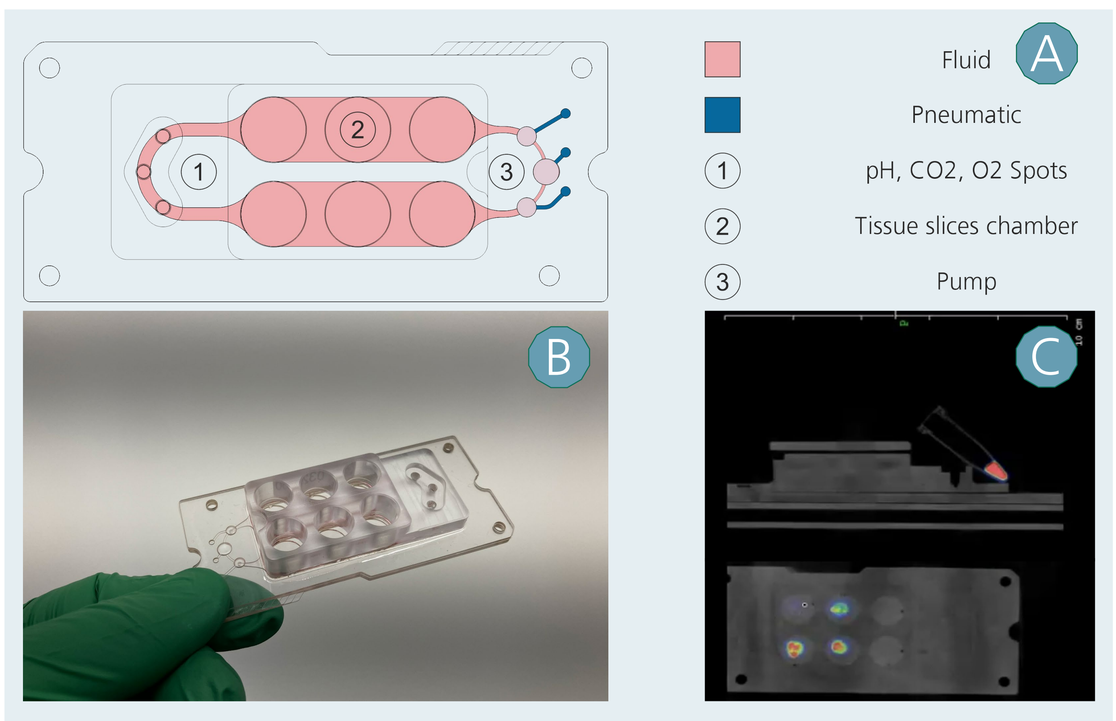
A major requirement for tissue derived *ex vivo* model systems in cancer and pharmacological research is to maintain the viability and functionality of the tissue. Depending on the target tissue, different aspects like nutrition, oxygenation and stimulation need to be addressed to maintain tissue-specific characteristics throughout the experiment. Moreover, suitable methods to validate cellular and extracellular parameters like viability, oxygenation or tissue morphology should be accessible. All these requirements can be implemented within micro physiological systems (MPS) . Here we show two vivid cases.

MPSsingle – a micro system for single organoid/tissue culture

Most experiments in early drug development and experimental research address a single tissue. Nevertheless, multiple endpoints and statistic methods require several technical replicates. MPSsingle is designed to combine high tissue model complexity and medium throughput. Therefore, six technical replicates are combined in a row within a fluidic circuit. Depending on the application, the size of the tissue model can reach up to 8 mm in diameter and 3 mm in height. An integrated, pneumatically actuated micro pump is driving the circulation of cell culture media and mediates the oxygen level in the micro physiological system [1].



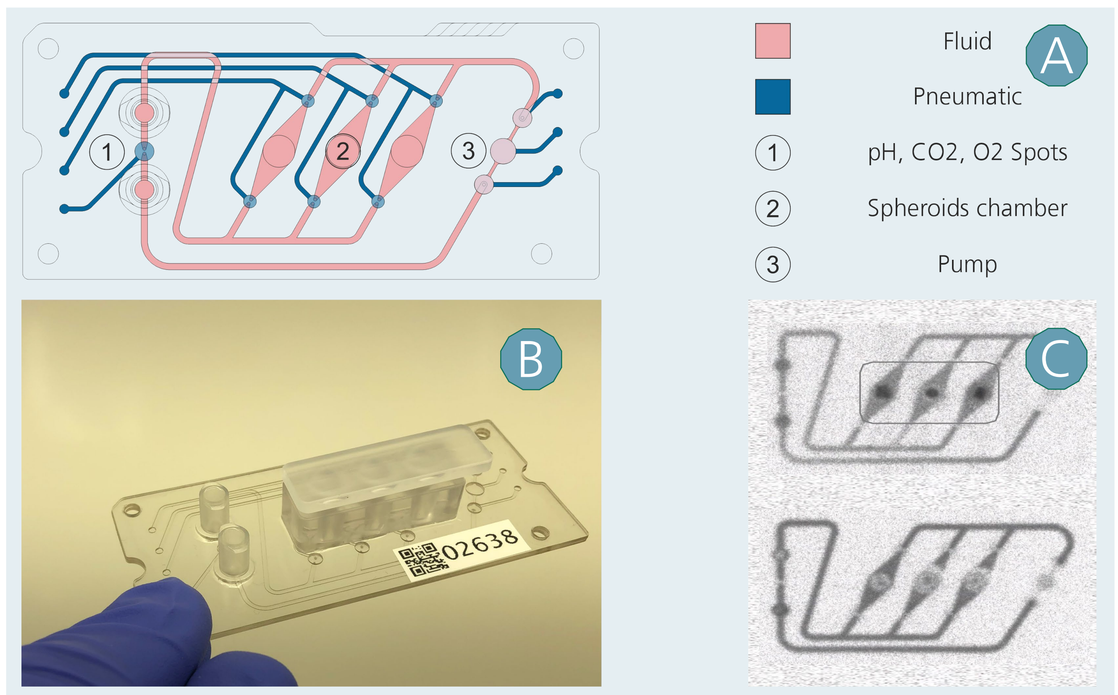
MPSsingle – a versatile system for long term culture of up to six similar organoids / tissue models. (A) - schematic top view; (B) - birds-eye view; (C) - combined image PET / CT with standard (dark red) in a vial on top of the system.

Features of the MPSsingle at a glance

Media volume	up to 4000 µl
Size of tissue chamber	Ø= 3-8 mm; hight= 10 mm
Number of tissue sections	6
Media flow	up to 10 µl/s
Compatible online monitoring	pH; CO_2; O_2
Compatible imaging platforms	Microscopy (BF, PH, Fluorescence); PET; CT; phosphor imaging autoradiography
Compatible liquid sampling Endpoints	WST; LDH; ELISA; PCR

MPSmulti – a micro system for multi organoid/tissue culture

During late stage preclinical drug development and in mechanistic experimental research the interaction of several organoids or tissues is of major importance. MPSmulti is designed as an open platform for multi organoid/tissue culture [2,3]. As all the organs within the human body are interconnected by the blood stream, media circulation is the basic driving force of distribution within MPSmulti. The system comprises a single circuit that integrates parallel connected reservoirs for up to three different tissue models. Depending on the application, the size of the tissue model can reach up to 8 mm in diameter and 3 mm in height. A pneumatically actuated micro pump is driving the media flow and oxygen level of the tissue models.



MPSmulti – a versatile system for long term culture of up to three different organoids / tissue models. (A) - schematic top view; (B) - birds-eye view; (C) - photostimulated luminescence of tumor organoids.

Features of the MPSmulti at a glance

Media volume	up to 800 µl
Size of resevoirs	Ø= 3-8 mm; hight= 10 mm
Number of culture reservoirs	3
Media flow	up to 10 µl/s
Compatible online monitoring	pH; CO_2; O_2
Compatible imaging platforms	Microscopy (BF, PH, Fluorescence); PET; CT; phosphor imaging autoradiography
Compatible liquid sampling endpoints	WST; LDH; ELISA; PCR

See the MPS and its application in action:

https://www.mdr.de/video/mdr-videos/c/video-691540.html

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1 Behrens, Schmieder et al. 2021 - PDMS free modular plug and play construction kit for the development of micro-physiological systems - DOI: 10.1117/12.2585203
2 Schmieder, Behrens et al. 2019 - A microphysiological system to investigate the pressure dependent filtration at an artificial glomerular kidney barrier DOI: 10.1515/cdbme-2019-0098
3 Sihver, Nitt-Weber et al. 2022 - Introducing micro physiological systems to evaluate new radiopharmaceuticals: A binding study with radiolabeled cetuximab DOI: 10.1515/cdbme-2022-1136

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