Blood-brain barrier on a chip with integrated monitoring system

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In recent years, the use of microphysiological systems, capable of reproducing the essential functions of organs in our body *in vitro* has spread. These biomimetic systems are called organ-on-a-chip (OoC) for their ability to reliably reproduce the physiological environment. OoC model in combination with continuous monitoring systems, such as multi-parametric sensors has several advantages over the traditionally used tests.

The study of the physiology of the blood-brain barrier (BBB) arouses special interest, since it is one of the most extensive and selective semi-permeable barriers of the central nervous system, which acts as a natural barrier that protects the brain from the entry of neurotoxic agents, and the invasion of pathogens and circulating blood cells.[1-2] It is therefore a barrier difficult to cross for vascular medicines that are directed to the brain. Moreover, the permeability of this barrier is directly affected in many neurodegenerative disorders (NDDs), which makes this platform an excellent tool for its study. But to have a complete picture of the disease and an appropriate environment for the BBB, neurons must be also included into the system.

BBB-oC models in the published articles do not reach physiological permeability values and are poorly reproducible. Most of the reported works monitor the evolution of BBB formation using immunolabeling and microscopy. Still only few examples describe integrated techniques inside the chip, such as biosensors, which are often applied in medical diagnostics and other areas. The use of biosensors can bring many advantages to BBB-oC in achieving automated monitoring of a wide range of analytes and biomarkers for personalized disease study or drug testing in NDDs.[3]

The goal of our project is to design models of BBB-oC that reproduce the physiology of the barriers including 3D co-culture of neurons with an exhaustive control of the permeability and inclusion of biosensors for monitoring in a reliable way.

References

[1] Pardridge, WM. J. Cereb. blood flow Metab. 32 (2012), 1959–1972.
[2] Van Tellingen, O., Yetkin-Arik, B., De Gooijer, MC, Wesseling, P., Wurdinger, T., De Vries, HE. Drug Resist. Update. 19 (2015), 1–12.
[3] Mir, M., Palma-Florez, S., Lagunas, A., López-Martínez, MJ, & Samitier, J. ACS Sensors. 7(5) (2022), 1237–1247.

Figures

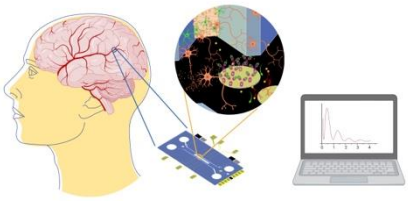

Figure 1: Schematic presentation of BBB-oC.