OR7

3D *in vitro* neuronal cultures with supported lipid bilayers

Chiara Ausilio, Claudia Lubrano, Valeria Criscuolo, Francesca Santoro
Tissue Electronics, Istituto Italiano di Tecnologia, 80125, Naples, Italy
chiara.ausilio@iit.it

Neurodegenerative disorders are characterized by progressive neuronal and synaptic loss which are often responsible for the gradual motor and cognitive dysfunction that affects patients. [1] In this scenario, organic and inorganic bioelectronic platforms have drawn a lot of attention in the last few years in light of their potential use as repair strategies in case of brain damages or injuries. [2] Here, the tight coupling between neurons and devices is broadly dependent on the surface interaction related to curvature, dimensionality and charge of the substrate.
In this sense, several biomimetic approaches have been tailored in order to recapitulate both the cell membrane dynamicity and curvature of the neuronal tissue. Among these, supported lipid bilayers (SLBs), a well-known biomimetic artificial cell membrane model, have proven to be a successful platform to optimize the cell-chip coupling.[3] Resembling the cell membrane dynamics and morphology, bioelectronic devices can be functionalized as real cells, to ensure the seamless integration of such platforms with the biological world. [4]–[6]
Here, we developed a functional neural biointerface with SLBs on pseudo 3D microstructures to ultimately recapitulate the dendritic spines morphology. To this purpose, we evaluated the role of lipids composition, fluidity, charge and curvature on neuronal polarization and network development. This biomimetic neural interface may pave the way towards a new class of in vitro platforms to construct artificial neural networks. We expect that the proposed approach could improve the recognition of artificial devices as part of their biological environment, thus maximizing cellular interactions at the interface. This platform might be further exploited to functionalize future implantable devices able to repair or replace neural systems.

[1] B. N. Dugger e D. W. Dickson, «Pathology of Neurodegenerative Diseases», *Cold Spring Harb Perspect Biol*, vol. 9, n. 7, pag. a028035, lug. 2017, doi: 10.1101/cshperspect.a028035.
[2] A. J. Shoffstall e J. R. Capadona, «2.5.7 - Bioelectronic Neural Implants», in *Biomaterials Science (Fourth Edition)*, W. R. Wagner, S. E. Sakiyama-Elbert, G. Zhang, e M. J. Yaszemski, A c. di Academic Press, 2020, pagg. 1153–1168. doi: 10.1016/B978-0-12-816137-1.00073-8.
[3] «Formation of Solid-Supported Lipid Bilayers: An Integrated View | Langmuir». https://pubs.acs.org/doi/10.1021/la052687c (consultato giu. 23, 2021).
[4] S. M. Ojovan *et al.*, «A feasibility study of multi-site,intracellular recordings from mammalian neurons by extracellular gold mushroom-shaped microelectrodes», *Sci Rep*, vol. 5, n. 1, pag. 14100, set. 2015, doi: 10.1038/srep14100.
[5] S.-E. Choi, K. Greben, R. Wördenweber, e A. Offenhäusser, «Positively charged supported lipid bilayer formation on gold surfaces for neuronal cell culture», *Biointerphases*, vol. 11, n. 2, pag. 021003, giu. 2016, doi: 10.1116/1.4945306.
[6] W. Hao *et al.*, «Lower fluidity of supported lipid bilayers promotes neuronal differentiation of neural stem cells by enhancing focal adhesion formation», *Biomaterials*, vol. 161, pagg. 106–116, apr. 2018, doi: 10.1016/j.biomaterials.2018.01.034.