3rd World Congress on
Nanoscience and Nanotechnology

October 21, 2021 | Webinar

Nanotechnology-based approaches for understanding intercellular communication and cellular interactions with materials

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Nano-materials can interact with cells to guide their organization and assembly into structures, with functionalities that support, improve or replace those displayed by biological tissues or organs, with applications in tissue engineering, biocomputing, cell-based sensors, diagnosis and analysis of pathologies and of drug efficacy. Using nanotechnology and advanced sensitive materials, we produced devices in which the topography of the substrate is controlled at the nanometer level to influence and guide the organization of single neural cells in clusters forming complex networks. In doing so, combining direct experiments with computer simulations and mathematical modelling, we studied how (i) the geometry of the surface can change the topological properties of the cells, (ii) the topological properties and number of elements in the system may affect and possibly improve the quality, density and spread of information throughout a network of cells and (iii) whereby cells create networks which minimize energy consumption [1–6]. This knowledge can be applied to decipher the mechanisms through which the brain marshals its millions of individual nerve cells to produce behaviour and, ultimately, reveal the circuits responsible for neurodegenerative disorders in that neurodegeneration can be regarded as a connective failure affecting information. In addition, we designed, fabricated and characterized various matrices embedding optical ratiometric microparticles sensors [7–9] for the measurement of cellular metabolism-related analytes, such as oxygen and pH, during cell growth and tissue formation. In particular, we developed additive manufactured 3D scaffolds embedding capsules-based optical sensors and demonstrated the potential of these integrated systems by calibrating and monitoring in space and time pH variations of human mesenchymal stromal cells (hMSCs) in different areas of the constructs. The research leading to these results received partial funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme.

Biography

Valentina Onesto received a Master degree in Biomedical Engineering from the Polytechnic of Milan, Milan (Italy) and a PhD in biomedical, system and applied nanotechnologies engineering from University Magna Graecia, Catanzaro (Italy). In 2016 she was a Visiting Researcher at the Italian Institute of Technology (IIT) of Genova (Italy) and in 2018 a Visiting Research Associate at King's College London, London (UK). From January 2019 she was a Senior Research Fellow Scientist at the CRIB@IIT of Naples (Italy). In September 2020 she started a Postdoctoral Researcher position at CNR-Nanotec in Lecce (Italy) within the ERC-Starting Project INTERCELLMED (No. 759959) and in July 2021 she became a Senior Postdoctoral Researcher in the same institute.

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