

Nanotechnology approaches in the design of hybrid constructs for biomedicine

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In Regenerative Medicine, Tissue Engineering has been integrating principles of engineering, chemistry, materials science, biology and health sciences in order to develop regenerative-based therapeutic strategies combining stem cells and biomaterials. The development of hybrid devices for tissue engineering are often inspired by the composition and complexity of native tissues. At the lowest level of such organization, one should select the adequate biomaterials to be used as the building block of the structure that will support cells and control their behaviour towards the production of new tissue. Nanostructured multilayered films have been often fabricated using the layer-by-layer technology, where consecutive layers of macromolecules are well stabilized by electrostatic interactions or other weak forces. Such multilayered could be then integrated in more complex porous macroscopic devices, often exhibiting a multi-scale organization. Using adequate templates, non-flat multilayers can be fabricated with tuned compositions along the build-up assembly, including patterned membranes or porous devices. This enables the production of very well controlled multifunctional and structural devices using mild processing conditions that could be useful in biomedicine, including in tissue engineering. In particular, we have been interested in developing more complex/hierarchical porous structures using natural-based polymers that could fulfil specific requirements in such kind of applications. Methodologies developed in our group will be exemplified, permitting the production of (i) 3-dimensional (open) porous nanostructured scaffolds for tissue engineering, enabling the support of cells, by combining LbL and rapid prototyping technology; and (ii) free-standing films featuring patterns to control cell orientation or micro-wells to provide local three-dimensional environments to the cells.