

The development of new technologies as well as research and analytical methods is a driving force contributing to significant progress in many fields of science. In medicine, the essential direction of development is regenerative medicine, its main goal is to stimulate healing, reconstruction and regeneration of damaged organs. Here the great potential exhibits tissue engineering, which assumes joining in laboratory conditions stem cells from a patient with 3D cell scaffolds and appropriate growth factors to produce the tissues needed for transplantation. This is a very dynamically developing technology, which in the future can significantly reduce the waiting time for transplantation while decreasing the risk of rejection. However, despite many studies, there are still significant uncertainties and unexplained issues regarding the integration of cells with scaffolds guided by material properties as well as the conditions of the cultures that regulate the basic issues of cell responses.

The goal of this project is to analyze and visualize in 3D the connections between cells and the scaffolds depending on their architecture and composition. For this purpose, advanced microscopy and reconstruction techniques will be used. The combination of scanning electron microscopy with focused ion beam (FIB-SEM) enables spatial analysis of various materials, including biological ones, at the nanometric scale. The study will be carried out on standard scaffolds used in bone tissue regeneration, composed of polymer fibers and hydroxyapatite particles. Such a scaffold structure is very similar to the extracellular matrix in bones, therefore it perfectly reproduces natural conditions. Cells can very effectively sense the surface properties of the material with which they stay in contact and adapt morphology, activity or proliferation in response to external environment. Therefore, the control of cell culture conditions, and above all the structure and properties of scaffolds is crucial for the proper tissue formation in laboratory conditions. The use of scaffolds consisting of two materials with different properties, chemical composition and stiffness as well as the 3D analysis proposed in this project will allow in-depth understanding of the behaviour of cells and ways of connection at the interface of two materials.

Detailed analysis and understanding of the key issues determining the proliferation, migration and differentiation of the cells within the scaffolds structure will have a significant impact on the development of tissue engineering field. As fast as possible access to effective and safe solutions that tissue engineering can offer is essential in successful treatment of an aging population.