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Biomimetic 3D Tissue Models For In Vitro Studies on The Immune Response To Biomaterials

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Abstract

After implantation of a medical product, the success of a therapy strongly depends on the host-initiated immune reaction (foreign body reaction). For the risk assessment of a medical product, the inflammatory reaction and the soft tissue reaction is standardly assessed after implantation in animals. In vitro tests on the interaction with blood components such as immune cells complement the gold standard. However, a poor correlation between in vitro and in vivo assessments slows the reduction of animals' burden in science. Our research focuses on the development of biomimetic 3D tissue models, which should be applied as time- and cost-efficient biomaterial screening platform. Differences between species strengthen our efforts to construct based on human macrophages and fibroblasts immune competent 3D models. In a comparative study, comprising clinical scenarios such as lipopolysaccharide contamination or the presence of IL-4, a statistical model of multi-parametric cytokine secretion profiles identified the surface treatment with human blood plasma as a predictive test condition. The reliability of the test condition was proofed by studies on polytetrafluorethylene (PTFE), silicone, polyethylene and titanium, finally correlating to state-of-the-art in vivo studies. This motivated our development of biomimetic 3D tissue models, resembling by a two-matrix-system, based on fibrin and collagen hydrogels, the matrix composition in a wound. After 13 days, vital macrophages adjacent to the biomaterial surface demonstrated the suitability of the biomimetic 3D models for longer contact to blood components. The soft tissue reaction after biomaterial contact was assessed by integrating fibroblasts in a 3D matrix. Multi-parametric analyses, compromising inflammatory and tissue remodeling parameters, generated a complex data matrix, finally characterizing the biomimetic 3D models. Most important, by reducing the dimensions of the data matrix, applying a principal component analysis, the reliability of the biomimetic 3D models predicted the fibrotic characteristics of the reference materials.

Biograph :

Maren Jannasch is an expert in Tissue Engineering and has a passion in modelling immune responses in vitro. Her biomimetic 3D model based on blood-derived macrophages in a 3D wound matrix creates new pathways for the improvement of in vitro biomaterial tests. She has built this model after five years of experience in academic research, presently at the Translational Center Regenerative Therapies located in Wuerzburg (Germany).