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Understanding interactions between biomaterials and biological systems using proteomics

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Abstract

The role that biomaterials play in the clinical treatment of damaged organs and tissues is changing. While biomaterials used in permanent medical devices were required to passively take over the function of a damaged tissue long term, current biomaterials are expected to trigger and harness the self-regenerative potential of the body *in situ* and then to degrade, the foundation of regenerative medicine. To meet these different requirements, it is imperative to fully understand the interactions biomaterials have with biological systems, in space and in time. This knowledge will lead to a better understanding of the regenerative capabilities of biomaterials aiding their design with improved functionalities (e.g. biocompatibility, bioactivity). Proteins play a pivotal role in the interaction between biomaterials and cells or tissues. Protein adsorption on the material surface is the very first event of this interaction, which is determinant for the subsequent processes of cell growth, differentiation, and extracellular matrix formation. Against this background, the aim of the current review is to provide insight in the current knowledge of the role of proteins in cell–biomaterial and tissue–biomaterial interactions. In particular, the focus is on proteomics studies, mainly using mass spectrometry, and the knowledge they have generated on protein adsorption of biomaterials, protein production by cells cultured on materials, safety and efficacy of new materials based on nanoparticles and the analysis of extracellular matrices and extracellular matrix–derived products. In the outlook, the potential and limitations of this approach are discussed and mass spectrometry imaging is presented as a powerful technique that complements existing mass spectrometry techniques by providing spatial molecular information about the material-biological system interactions.