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Static versus dynamic fibronectin adsorption on bioactive glasses: impact on surface properties and biological response

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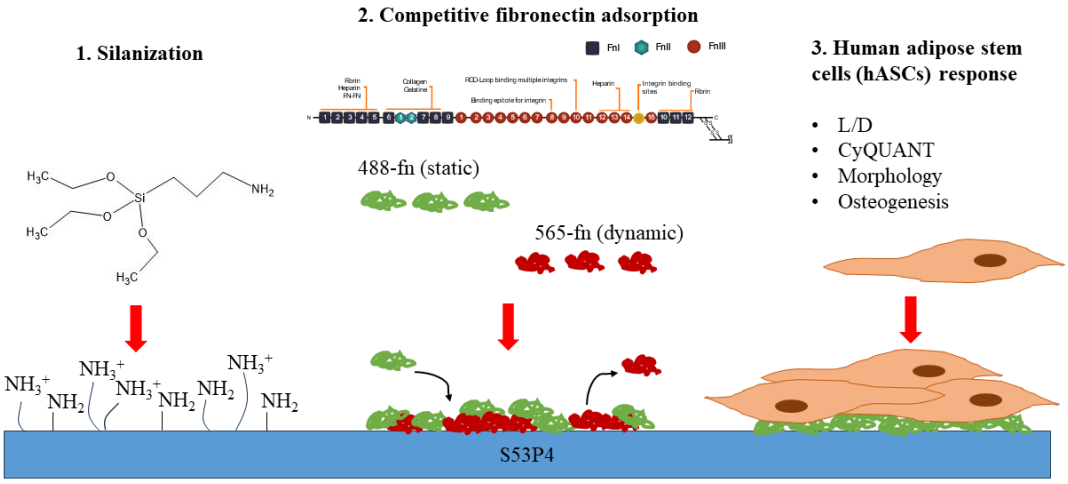
Project:



Abstract.

Bioactive glasses (BGs) are a promising class of biomaterials for bone tissue regeneration due to their high biocompatibility and bioactivity. Particularly, silicate BGs interact with body fluids, inducing a specific series of chemical reactions, based on ion exchange, leading to the precipitation of a hydroxyapatite layer. Moreover, BG surfaces are prone to be functionalized to tailor properties such as, but not limited to, dissolution rate or osteoconductive/osteoinductive response. When implanted, silicate BGs also interact with the surrounding chemical and biological moieties. Especially proteins are of particular interest, since their adsorption at the biomaterial surface is crucial in determining the fate of the implant, either promoting or limiting

the adhesion of the cells and tissue of interest. However, despite of the wide knowledge gained on BGs and protein, separately, the protein-biomaterial interactions is not fully understood. The limited understanding of such interaction is correlated with a poor correlation between in-vitro and in-vivo results, where 50% of bioceramics found promising in-vitro, failed in-vivo. The aim of our study was to investigate protein adsorption on BGs as a function of their physicochemical properties, and their impact on the biological response. The FDA-approved S53P4 (SiO2 53.85, Na2O 22.66, CaO 21.77, P2O5 1.72 mol%) was used as a reference and its surface modified by silanization with 3-aminopropyltriethoxysilane (APTES). Samples surface physico-chemical properties where characterized by contact angle, zeta potential, X-ray Photoelectron Spectroscopy (XPS) and Fourier-Transform InfraRed-Attenuated Total Reflectance (FTIR-ATR) spectroscopy. Fibronectin, considered as a model protein, was adsorbed, in static and dynamic, on bare and silanized substrates. Fibronectin quantity, distribution and fibrillogenesis were evaluated by fluorescent confocal microcopy, which highlighted the improved homogeneity of fibronectin distribution on the silanized surface. The change in fibronectin conformation as a function of the surface properties was then investigated by deconvoluting the amide I band, extracted from the FTIR-ATR spectra. Regardless of the surface properties, a significant decrease of random coils and a more organized structure (β-sheets) were observed after the adsorption. The impact of the adsorbed fibronectin on cell behavior was then evaluated in-vitro with human adipose stem cells (hASCs). Cell viability, proliferation, morphology and the expression of relevant genes were studied, showing a good cytocompatibility and osteogenesis. Cell spreading was found highly affected by the presence of fibronectin, leading to preferential cell orientation. Overall, fibronectin adsorption was highly surface-dependent and prone to mediate the interactions between cells and biomaterials, influencing the biological response.