Depicting the immunological characterization of graphene-based materials

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Abstract

Graphene-based materials (GBMs) represent promising tools for biomedical applications. We previously demonstrated that the design of specific physicochemical characteristics allows the production of materials with enhanced immune-modulating properties [1-3]. However, further studies are needed to fully clarify which specific immune cell subpopulations are modulated and able to internalize GBMs.

Hence, we applied an innovative approach to dissect the immune profiling of GBMs at the functional and molecular level by single-cell mass cytometry and whole-transcriptomic analysis. We first evaluated the impact of different functionalized GOs on immune cells. Thanks to GO combination with inorganic quantum dots (GO-QD) enabling its detection by single cell mass cytometry, we highlighted that B cells and monocytes are the main immune cells able to internalize GO. The amino functionalization of GO (GONH2) improved the compatibility at the immune level, reducing its impact on cell metabolism. Intriguingly, deeper analysis at the functional level demonstrated that GO, and in particular GONH2, induces a specific M1-like activation on monocytes and the secretion of IL-4 and Granzyme-B from B cells skewing a cytotoxic-like response. Moreover, the distinctive modulatory properties of GO on monocytes were combined with well-recognized osteoinductive capacity induced by the functionalization with calcium phosphates. This novel biocompatible nanomaterial, was able to induce osteoinductive stimuli increasing bone regeneration in vitro and in vivo. Finally, we evaluated the effects of graphene nanoribbons (GNRs), we found a very high immune compatibility compared to graphene oxide. The immune system governs every aspect of our health; our results demonstrate that specific design and functionalization of GBMs offer new strategies for the modulation of immune cell functionality, providing very promising future perspectives for their biomedical applications.

References


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