Graphene and WS_2 interactions with neutrophils and MSCs for nerve injury regeneration

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The employment of graphene and 2D materials in tissue engineering has been recently exploited for the repair and regeneration of nerve tissue. Among the possible applications, these relatively new materials display a great potential as peripheral neural interface, especially thanks to their unique combinations of electrical, optical and tribological properties [1-5].
However, the use of these innovative materials has raised questions about their interaction with immune cells, including neutrophils, whose immune response is known to influence the regenerative outcome [6], and mesenchymal stem cells (MSCs), a novel therapeutic avenue for peripheral nerve regeneration [7].
In this work we investigated graphene and WS_2 influence on neutrophils and MSCs. We tested WS_2 on sapphire and different CVD graphene, namely graphene on sapphire, graphene on SiC, both as-grown and H-intercalated, graphene grown on copper and transferred on glass, to assess the effect of the substrate and growth technique.
We first characterized neutrophil activation and discussed how material properties influenced the NETs production and their adhesion to the substrates. Furthermore, planar graphene resistance to NETs-induced degradation was carefully investigated and compared with the results reported for graphene oxide [8]. Ultimately, 2D materials cytocompatibility for MSCs are tested to estimate cell viability, morphology and mitochondrial health.
Overall, our results are aimed at understanding the interface between 2D material and some of the players involved in nerve injury, a critical point for regenerative medicine.

References and Acknowledgement

[1] Qian et al., NPJ Regen. Med., 6, (2021) 31
[2] Bramini et al, Front. Syst. Neurosci., 12(2018) 12
[3] Convertino et al, Front. Neurosci., 12 (2018) 1
[4] Convertino et al, Nano Lett., 20 (2020) 3633–3641
[5] Convertino et al, Front. Neurosci., 14 (2020) 592502
[6] Keshavan et al, Cell Death and Disease, 10 (2019) 569
[7] Lavorato et al, J. Mol. Sci., 22 (2021) 572.
[8] Huang et al, Adv. Healthcare Mater. 2022, 11 (2022) 2102439.

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Figures

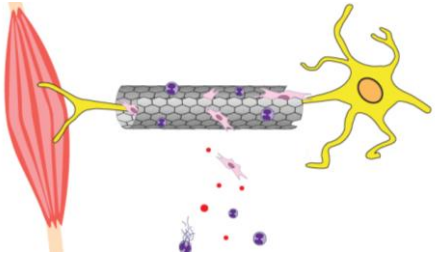

Figure 1: Graphene conduit for nerve regeneration