Strategic Functionalization of Nanomaterials for Potential Biomedical Applications

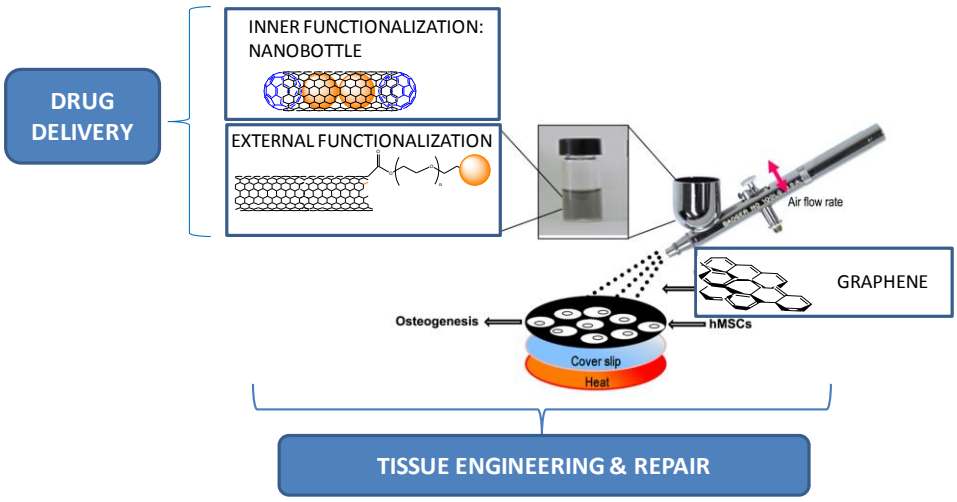
Giorgia Pastorin

Pharmacy Department, National University of Singapore, 3 Science Drive 2, Block S15#05-PI-03, Singapore 117543

Recent advances in nanomaterials have led to several opportunities in biomedical research. The current and most promising applications of these nanomaterials include, but are not limited to, drug delivery and tissue repair. Indeed, drug delivery systems represent one of the most interesting results deriving from the development of advanced materials, among which carbon nanotubes (CNTs) seem to embody an intriguing option; this is due to some favorable attributes including CNTs' unique shape, which promotes cellular-uptake, and large aspect-ratio that facilitates functionalization of bioactive molecules on their surface [1,2].

In our group we have investigated several strategies for the incorporation of different drug molecules both *via* covalent linkage [2] and *via* encapsulation in form of "nano-bottles" [3-5]. The efficacy of drugs released from our drug delivery systems was improved *in vitro* in comparison with the free drug, probably due to remarkable mitochondrial injury, as demonstrated by the decrease in mitochondrial membrane potential resulting from accumulation of CNT-drug constructs at the mitochondrial level. Conversely, empty carriers neither reduced cell viability significantly nor incurred mitochondrial damage.

Also, we have demonstrated that carbon-based materials might provide a promising biocompatible scaffold in tissue engineering, since they do not hamper the proliferation of human mesenchymal stem cells (hMSCs) and accelerate their specific differentiation into bone cells [6,7]. Interestingly, cell differentiation occurred even in the absence of additional biochemical inducing agents, as evidenced by multiple independent criteria at the transcriptional, protein expression and functional levels [6]. Since the differentiation rate is comparable to the one achieved with currently used growth factors, these results pave the way for the potential use of these nanomaterials for stem cell research.



References

[1] B.S. Woong *et al. Adv. Drug Deliv. Rev*. **2013**, *65*, 1964.
[2] G. Pastorin *et al. Chem. Commun.* **2006,** *21*,1182.
[3] Zhao C. et al. *Biotechnol. Adv*. **2013**, *31*, 654.
[4] W. Wu *et al. Angew. Chem. Int. Ed.*, **2005**, *44*, 6358.
[5] R. Yupeng and G. Pastorin. *Adv.Mater*. **2008**, *20*, 2031.
[6] J. Li *et al. Chem. Sci.* **2012**, *3*, 2083.
[7] S. L. Yoong *et al. Biomaterials*, **2014,** *35,* 748.
[8] T. R. Nayak *et al. ACS Nano.* **2010**, *4*, 7717.
[9] T. R. Nayak *et al. ACS Nano.* **2011**, *5,* 4670.