Tuneable nitric oxide generation using selenium nanoparticles

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Nitric oxide (NO) is a signalling molecule involved in a wide range of physiological and pathological processes. Its effects are concentration dependent, promoting cell survival and proliferation at low concentrations (nM), or having antibacterial/anticancer properties at higher concentrations (μM).[1] The significant role of NO in neuroscience, physiology, and immunology, has promoted the development of NO delivery strategies. The key limitation of NO delivery relates to its short half-life (5s), limiting diffusion distance in human tissue. To address this issue, strategies were developed which encapsulate NO donors and release the load at the target site.[2] However, these approaches are restricted by their limited payload, making them impractical for long-term applications. Consequently, catalytic approaches have emerged to tackle this issue. Nanomaterials have been employed as enzyme mimics to stimulate the catalytic decomposition of endogenous NO prodrugs to achieve sustained *in situ* NO generation.

Selenium, an essential element in various enzymes/proteins, has been shown to trigger the catalytic generation of NO from NO donors.[3] This has been demonstrated using modified selenium compounds such as selenocystamine and selenocystine.[4] However, no study has evaluated the NO-generating capacity of selenium nanoparticles (SeNPs). This is important as SeNPs are less toxic than their organoselenium counterparts,[5] and nanoparticles are known to be efficient catalysts due to their large surface to volume ratio. Herein, we synthesized SeNPs and investigated their capacity to generate NO by evaluating the effect of nanoparticle crystallinity, type of NO prodrug and buffer composition. NO generation was tuned by regulating the NO prodrug and SeNPs concentrations. The NO generation is sustainable, showing the same catalytic activity in each cycle of reaction (Figure 1a). The SeNPs were stored for 2 months with no decrease in performance and were shown to be biocompatible (Figure 1b). Owing to the high stability, biocompatibility, and NO generating property, we then demonstrated the ability of SeNPs to disperse bacterial biofilms in the presence of endogenous NO donors.

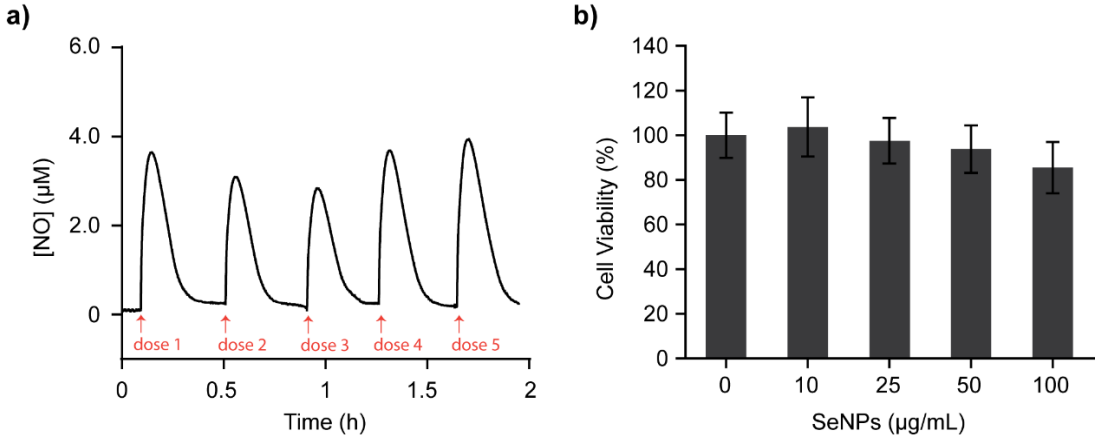

Figure 1: a) Sustained NO generation profile from SeNPs suspension (100 μg/mL) in the presence of GSNO (12.5 μM) and glutathione (1mM) at 37 °C for 5 cycles. b) Cytotoxicity of SeNPs towards NIH 3T3 cells after 24 h incubation (37°C, in DMEM).

References

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