Investigation of Polymer-Functionalized Carbon Nanotubes for Nanomedicine

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The field of drug delivery can benefit from nanoparticle systems which can deliver drugs with high efficacy and low toxicity for therapeutics or antimicrobial treatment. Physicochemical properties like size, chemical functionalities, and aggregation modulate cellular uptake and toxicity profiles of these systems.

Copolymers with well-controlled molecular weight have been actively explored to achieve functional micelles with narrow size distribution for controlled, efficient delivery of therapeutics. However, challenges of these systems include destabilization of the cell membrane leading to cytotoxicity at therapeutic drug doses and micelle destabilization due to dilution in blood when administered intravenously. In contrast, Pantarotto et al. demonstrated carbon nanotubes behave like nano-needle molecular transporters, readily taken up by cells with comparatively much lower cytotoxicity. Others have shown cell uptake is length dependent and toxicity is affected by chemical functionality of the nanotube surface. However, dispersing functionalized nanotubes suspended in aqueous medium have proved especially challenging. Therefore, it is hypothesized that a synergistic combination of the multiple capabilities of carbon nanotubes and polymeric systems can lead to the development of powerful multi-functional nanomedicine applications.

In this project, stable nanotube-polymers conjugates in aqueous media have been characterized using Raman spectroscopy. Excess polymer has also been shown to be successfully filtered via dialysis. Preliminary genetic material loading demonstrations have been conducted, but more experimentation is needed. Future plans include demonstrating drug loading and cell uptake in microbes and cells. Cytotoxicity would also need to be evaluated to demonstrate whether these can be employed as a viable platform for drug delivery.