Application of pH-Responsive Nanogels for Targeted Drug Delivery

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Drug delivery devices specifically transport drugs to help reduce drug toxicity to healthy cells and repetitive drug administrations. This study analyzes the use of pH-responsive nanogels, polymer nanoparticles that can expand and shrink in response to pH-changes, as a drug delivery device. These nanogels have the potential to specifically target diseases characterized by a lower pH environment, such as cancer and kidney disease, by releasing drugs in a low pH and withholding drugs inside at a high pH. Poly(NIPAm-co-DEAEM) nanogels were synthesized using dispersion polymerization of N-isopropylacrylamide and 2-(Diethylamino)ethyl methacrylate. Optimization of nanogel response was done through modification of surfactant (SDS) and crosslinker concentrations. The optimal nanogel solution was chosen on the criteria that the nanogel's expansion and shrinkage occurred in a pH range of 6.5-7.1. Absorbance versus pH data on the optimal nanogel supported nanogel expansion from pH 1.0-7.04 and shrinkage from pH 7.04-9.0. Drug loading into the optimal nanogel was modeled using cyclophosphamide and showed successful retention of cyclophosphamide with positive colorimetric observations. The control (non-loaded) nanogels were biocompatible with neurons with a 90.34% viability. Cyclophosphamide was shown to be cytotoxic with a 28.75% viability ($p<0.01$). Cyclophosphamide loaded nanogels had an insignificant 88.55% viability compared to the control ($p>0.01$) which shows that cyclophosphamide was strongly withheld in the nanogel, reducing any neuronal cytotoxic effect. The data supports the effective use of Poly(NIPAm-co-DEAEM) nanogels for targeted drug delivery by effectively withholding cytotoxic drugs in higher pH media common of benign cells.