Advanced Au-SPIONs: Synthesis and Characterization of Multifunctional Nanoparticles for Personalized Nanomedicine

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Nanomaterial synthesis has gained widespread attention in personalized nanomedicine to offer promising treatments for combined therapy and diagnostics. Capable of disease detection, drug delivery, and tumor ablation, multifunctional nanoparticles can be carefully synthesized by the Turkevich method for various biomedical goals. In this study, superparamagnetic iron oxide (SPIO) nanoparticles coated with multiple gold layers were created by modifying gold and sodium citrate surfactant ratios for nanosphere size efficacy regarding physicochemical and optical properties. Transmission electron microscopy was used to characterize the uniform gold-SPIO nanoparticles (Au-SPIONs) with average diameters ranging from 13.1 - 27.6 nm, while UV-Vis spectroscopy calculated maximum surface plasmon resonance bands centered around ±523 nm. Photothermal therapy testing was then followed by irradiating 26 nm diameter Au-SPIONs with a 527 nm laser, and an elevated temperature of 47°C was reached within 8 minutes – optimal for selective tumor hyperthermia with minimal harm to healthy tissue. Nanoparticles (26 nm) were then cultured in triplicate with preosteoblast MC3T3 cells for cell viability assay to confirm non-cytotoxicity, and >99% of cells remained viable after 24 hours for all concentrations (10-80 µg/ml) tested. Data acquired supports the potential of magnetoplasmonic Au-SPIO nanoparticles with a core/shell structure for safe and cost-effective biomedical applications in non-invasive imaging, drug delivery, and localized photothermal therapy. Looking forward, nanoparticle functionalization with a neurotrophic growth factor will be completed to direct neuronal stem cell differentiation and tumor apoptosis for simultaneous neurodegenerative disease and brain cancer therapeutics.