Engineering of Polysaccharide-Based Nanoparticles for Theranostic Applications

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The current method of treatment of patients in the healthcare system, to first diagnose a condition and then to apply a known therapy, is time-consuming and expensive. These treatments may have adverse side effects since they are un-individualized, even for diseases like cancer, which require tailored treatments. The field of theranostics aims to turn these two-step procedures into a single step, and theranostic nanocarriers, which are nanoparticles that can be used for both diagnostic imaging and drug delivery, are being developed so that physicians can monitor drug release/distribution and the patient's response in real time. Currently, polysaccharide-based nanocarriers contain metallic imaging agents, which has raised concerns of toxicity and slow excretion from the body. This project aimed to synthesize a multi-stimuli responsive nanocarrier that uses fluorescent carbon-dots as its diagnostic component. Using pH-responsive chitosan, temperature-responsive hydroxypropyl cellulose (HPC), and fluorescent carbon dots, nanoparticles were synthesized and then characterized. Transmission electron microscope imaging showed that the particles were spherical in shape and a fluorometer confirmed that they exhibited strong fluorescence. An MTT assay proved the hybrid nanoparticles were nontoxic. They were able to reach the cytoplasm of HEK 239 and 231-BR cells, where they were visible via laser confocal microscope. The nanoparticles had a high drug loading capacity for an alpha-factor peptide and displayed sustained drug release, and they could effectively convert NIR light to heat for photothermal triggered drug release. The successful development of multifunctional polysaccharide-based hybrid nanoparticles opens a new pathway toward the development of theranostic agents.