Ultra-Small Multimodal and Multifunctional Chitosan Nanoparticles Utilized as Biodegradable Bio Imaging Agents and Drug Delivery Vehicles

Advantages
• Chitosan nanoparticles are highly biocompatible and biodegradable
• Quickly and efficiently combines multiple diagnostic techniques creating a truly multi-modal nanoparticle
• Also acts as a drug delivery vehicle making the particle multifunctional
• Tagging of particles also allows for easy tracking of investigational drugs within the body

Invention
Methods and materials for both the creation of ultra-small Chitosan nanoparticles and their fictionalization by: labeling with fluorescent tags; linking to MRI or other bio-imaging contrasting agents; linking with iodine containing agents to be radio-opaque; doping with pharmaceuticals for drug delivery and other methods to create bi-modal or multi-modal nanoparticles.

Background
Biomedical imaging techniques allow for advanced diagnostic procedures such as visualization of physiological structures, measurement of biological functions and evaluation of cellular and molecular events without invasive procedures. Doctors often use multiple such procedures involving different imaging machines to ensure accurate and thorough diagnosis of disease. These procedures make use of different modalities (such as light, radiation and sound) to analyze the way these sources interact with cells, tissue, or organs in the body. Current apparatus and procedures each use only a single modality such as: ultrasound, X-rays, MRI, optical, endoscopic or spectroscopic techniques (fluorescence, etc.). Thus, in order to obtain multi-faceted data, surgeons rely heavily upon data processed by image-fusion software which uses multiple single imaging modalities. This fusion of data often generates artifacts (false images) which can lead to misdiagnoses or for some diseases to go unnoticed. Currently contrast agents are used to boost signal-to-noise ratios which provide better image quality. Still, these agents are non-targeted and designed for a single imaging modality. Development of a high resolution, target specific agent with multimodal imaging capabilities would be highly successful and provide immediate commercial applications.

Scientists at UCF have developed a highly efficient method for the creation of ultra-small Chitosan (polysaccharide derived from chitin) nanoparticles. Chitosan nanoparticles are very biocompatible/biodegradable, making them ideal for in vivo applications. Methods have also been developed that link/bind various contrasting agents to the Chitosan nanoparticles, including: fluorescent tags, paramagnetic sensitive agents and iodine containing agents to be radio-opaque. These nanoparticles are sensitive to multiple scanner modalities. For example if a nanoparticle had both fluorescent tags and enhanced magnetic sensitivity, these particles would allow for use with both MRI and fluorescent imaging. Thus a variety of different tests can be performed simultaneously, by placing multiple scanners side by side. This has the advantage of eliminating the need to move the patient from one machine to the next. Not only do these nanoparticles work as imaging agents, but they also serve as drug delivery vehicles. Pharmaceuticals can be attached to the nanoparticles which would then be taken into the cells and tissues of the patient and tracked using a fluorescent tag. Once inside the cell, the biodegradable core would be dissolved releasing the drug to act on its target. Overall these nanoparticles are highly sensitive, non-invasive, accurate, and would significantly increase the possibility for early diagnosis.

Application
Chitosan nanoparticles would allow for multiple diagnostic techniques to be carried out at one time, as well as providing more contrast for better visualization in biological systems. This would create better, faster diagnostic techniques that could all be done in one facility. Also these particles could be used for drug delivery into biological systems and monitoring rates and effectiveness of drug uptake into cells. The technology would be of interest to any medical imaging or diagnostic companies as well as the pharmaceuticals industry.

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