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Multifunctional Nanomaterials at the Interface of Cancer Diagnosis and Therapy

Abstract:

Nanomaterials are reshaping the landscape of cancer diagnosis and therapy by enabling early detection, targeted delivery, and enhanced therapeutic efficacy. This presentation showcases two complementary nanomaterial-based platforms designed to advance cancer theranostics. The first system involves a novel hydrogel composed of carboxymethyl cellulose (CMC) incorporated with nanographene oxide (nGO) for bioimaging-assisted cervical cancer diagnostics. Leveraging the distinctive optical and electrical properties of nGO, this hybrid hydrogel exhibits superior bioimaging performance, allowing early-stage detection of malignant cells. The CMC/nGO hydrogels display outstanding antioxidant activity (~90%) and excellent biocompatibility (>90%), underscoring their potential as multifunctional biomaterials for combined diagnostic and therapeutic applications. The second approach focuses on a targeted drug delivery system using camptothecin (CPT)-loaded mesoporous silica nanoparticles (MSNs) functionalized with CpG oligodeoxynucleotides (CpG ODN) for skin cancer treatment. The chitosan-coated MSNs achieve high drug encapsulation efficiency (\approx 95%) and targeted release, while the CpG ODN component stimulates antitumor immune responses. In vitro and in vivo results demonstrate enhanced cytotoxicity toward cancer cells and significant tumor regression. Collectively, these findings illustrate how nanomaterial-driven platforms can integrate bioimaging, immunomodulation, and controlled drug delivery into a single therapeutic strategy, paving the way for the next generation of precision cancer therapies.

Biography

Pedro Fonte is an Assistant Professor at the Faculty of Sciences and Technology, University of Algarve, and a researcher at CCMAR and iBB-Institute for Bioengineering and Biosciences, University of Lisbon. His research focuses on the design of nanocarriers for targeted and controlled drug delivery, overcoming biological barriers to enhance therapeutic precision. He has led multiple funded research projects and authored over 60 peer-reviewed papers, book chapters, and an edited volume. Recognized among Stanford University's Top 2% Scientists, he has received numerous international distinctions.