Indian Institute of Science
Centre for BioSystems Science and Engineering
BSSE Seminar

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DNA Enabled Design of Multimodal Nanoparticles for Cancer Theranostics

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ABOUT THE SPEAKER

Dr. Suchetan Pal obtained his B. Sc. and M. Sc. in Chemistry from Jadavpur University and Indian Institute of Technology, Kanpur respectively. Then, he went to Arizona State University, for his doctoral studies. After completing the thesis work on "DNA directed self-assembly of plasmonic nanoparticles," Dr. Pal moved to a joint post-doctoral position at Columbia University and Brookhaven National Laboratory. He had completed another postdoctoral stint at the Memorial Sloan Kettering Cancer Center, before joining Indian Institute of Technology, Bhilai as an assistant professor. His primary research focus includes biomolecular nanotechnology for drug delivery, biosensing and bioimaging. Till date, he has published 20 research papers with more than 1800 citations.

ABSTRACT

Cancer is one of the deadly diseases affecting millions of patients financially and economically. Despite recent advancements in cancer treatment, surgical removal of the primary tumor remains prescribed line of treatment for solid cancers. In practice, surgeons rely on preclinical imaging (such as MRI, PET) and visual inspection aided by histology for tumor resection. Often that leads to incomplete removal of the tumor and therefore increase the chance of the recurrence. Currently, contrast agents which can distinguish cancer tissue from healthy tissue in the operating room are most sought after. In this abstract, we present the development of multimodal optical contrast agents for cancer imaging and therapy. Recenttly, Deoxyribonucleic acid (DNA), the "blueprint" of life, have shown immense potential in the self-assembly of well-defined nanoscale structures. These self-assembled nanostructures are extensively utilized for nanophotonics, (bio)sensing and drug-delivery applications. This emerging field is collectively called "DNA nanotechnology." We used a DNA nanotechnology-based approach to develop multimodal nanoparticles for efficient multimodal cancer imaging and therapy. The multimodal nanoparticles synergistically combine the specificity of Raman spectroscopy, the versatility and speed of fluorescence imaging and deep tissue penetration capability of the photoacoustic modality. DNA-enabled molecular engineering allows the rational design of triple modal nanoparticles. With the prediction from molecular dynamic simulations and electromagnetic calculations, a detection limit as low as 5 femtomolar was achieved. In vivo mouse model of cancer, triple modal nanoparticles selectively accumulate in tumor tissue. This enables pre-surgical deep tissue imaging using photoacoustics, real-time fluorescence imaging for tumor detection, resection, and subsequent Raman-based verification of clean margins. Furthermore, triple modal nanoparticles enable highly efficient image-guided photothermal ablation of tumors, widening the scope of the nanoparticles into the therapeutic realm.