EDITORIAL

Nanotechnology in biomedicine

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The use of advanced Nano materials are at the leading edge of the rapidly developing field of nanotechnology and have attracted increasing interest of current researchers globally because of their unique physico-chemical, biological, optical, electrical and magnetic properties. Both inorganic as well as organic nanomaterial's have been well explored for their wide range of applications in catalysis, sensors, photonic devices etc. but their study in the biomedical field is relatively new and seems to be a promising tool for providing great benefits to our society in future. Nano materials are under investigation in various areas of biology and medicine that includes proteomic and genomic studies, disease diagnostics, pharmaceutical screening, drug delivery, protein purification, cancer therapies, and bio-imaging.

Advances in nanotechnology have prompted rapid progress in drug delivery and targeted drug therapies. The Nano drug delivery systems includes nanoparticles, micelles, liposomes, colloidal dispersions, polymer drug conjugates and many more. Liposomes are one of the most versatile components for selective drug and gene delivery. Several liposomes based formulations has been clinically approved and several under trials for specific drug deploy for the treatment of a variety of cancers [1]. The first FDA approved nanomedicine for cancer treatment; which consisted of doxorubicin (DOX) loaded in a liposomal construct (DOXIL) for the treatment of Kaposi sarcoma, ovarian cancer, and multiple myeloma. Dendrimeric structural moieties where the drugs binds covalently to the dendrimeric sites also allowing controlled drug release, and thereby making them very effective drug delivery carriers [2]. Metal (for example Au [3] and Ag [4]) as well as metal oxide nanoparticles have also shown to be the potential candidate as targeted drug delivery vehicles, fluorescent bio-imaging agents, and also in therapeutic treatment of variety of cancers with minimum collateral damage to healthy tissues/cells. Several current bio-imaging techniques such as fluorescence imaging, Raman imaging, computated tomography (CT), positron-emission tomography (PET), magnetic resonance imaging (MRI), Ultrasound have been used for monitoring effective drug delivery as well as for early diagnosis. The first magnetic nanoparticle tested in molecular imaging were super paramagnetic iron oxide nanoparticles, used as a contrast agent in MRI [5]. Fluorescent nanoparticles, with intrinsic fluorescence or loaded with fluorescent dyes such as porphyrinoids have also been explored as imaging agents. A high fluorescence quantum efficacy and photostability is the key towards the good contrast agent. Several organic materials based fluorescent agents are under investigation to be used as potential contrast agents for different imaging techniques.

Several nanoparticles that include carbon based nanomaterials, gold based nanomaterials, metal nanoparticles, and organic polymers have shown potential to be used as effective therapeutic agents for photo thermal therapy (PTT) and photodynamic therapy (PDT). Both PTT and PDT employs the use of light to destroy the cancer cells. PTT employs photon energy absorbed by PTT agent and convert it into heat energy to destroy cancer cells. The use of Nano medicine can be advantageous to facilitate this process. A high light-to-heat conversion capability are among the most important characteristics for a good PTT agent. A variety of photothermal nanotherapeutics agents that includes metallic nanoparticles, Nano grapheneoxide (GO), transition metal oxides/sulfides and organic nanoagents have been extensively studied [6,7]. Engineered gold nanoparticles have shown to be a promising PTT agent [8]. PDT involves the use of a photosensitizer (PS) that is administered to the tumor site and selectively irradiated with laser light of specific wavelength based on the PS to kill the cancer cells. Several natural as well as synthetic biopolyesters and biopolyacrylamide based nanoparticle formations have been reported to effectively deliver PS to the cancer sites to increase the PDT efficacy [9]. Even though the monotherapies seem to be promising to cure, but combination of therapies can serve better and have shown better results than individual monotherapies [10]. One such example was reported by Sahu et.al [11], where they have shown a pluronic coated nano GO sheet complexed with methylene blue, a photosensitizer efficiently delivered the PS into cancer cells and showed enhanced anticancer effect by combined PDT-PTT effect.

The examples above show that the unique physicochemical and biological properties of nanomaterial's make them an important class of advanced material for future science and can bring a revolutionary change in the biomedical field, but a deep understanding of their mechanistic path for delivery, interactions at the cellular level and their side effects needs to be well evaluated for the better future of Nano science.

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