

Current Research Trends and Growing Importance of Nanomedicine

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The science behind the design and development of nano-scale materials has expanded tremendously over the past few decades owing to the improvement and sophistication of nanoscale level physicochemical characterization tools and techniques and has consequently enabled evolution and advancement of technological applications in diverse fields of practical utility. The applications of nanoscience and nanotechnology in the fields of medicine (both diagnostic and therapeutic) and in agriculture has had a great impact in the recent years.

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Nanomedicine research has immense relevance and importance in pharmacokinetics, drug delivery as well as development of remote non-invasive photothermal therapy. Several nanostructures were designed, developed and fabricated such as nano rods, wires, tubes, ribbons, fibers, particles, spheres, and dots with novel utilities. For example the synthesized silver nanoparticles were found to be toxic against a broad spectrum of pathogenic bacteria devoid of any critical toxicity to the humans. In addition silver nanoparticles were also found to have anti-inflammatory properties that are useful in quick and safe healing process. Magnetic nanoparticles were successfully developed for drug and gene delivery applications. Magnetic nanoparticles were found to be very useful in diagnostics as well as hyperthermia treatment [1] with some reaching the level of commercial scale production for biological and biomedical applications. Development of biosensors, and imaging probes based on nanoparticles has immense significance in diagnostics. Recently substantial advancements were made in the application of magnetic nanoparticles as contrasting agents in magnetic resonance imaging and even as tracer materials in magnetic particle imaging

[2]. Zinc oxide nanostructures were found to exhibit antibacterial activity against food borne pathogenic bacteria [3].

During cancer therapy, the use of nanoparticles in biomedicine has significant advantage over chemotherapy and radiotherapy aiding in specific treatment of tumor cells while keeping the body cells safe. Nanomedicine has made it possible for the targeted delivery of drugs, proteins, nucleic acids and immune agents. Metastasis of cancer is the leading cause of cancer related mortality. Since nanomaterial has great potential to modulate the immune system, nanotechnology based immunotherapy has immense relevance in the cancer metastasis [4].

The use of nanoparticle based drug delivery vehicles facilitate the reduction of drug side effects due to use of low dose of the drug molecules in targeted drug delivery therapeutic approach [5]. Nanomedicine also holds a great promise in tissue engineering and regenerative medicine as well. More over nanomedicine had played a major role in bringing about cost effectiveness in treatment [6].

However research in nanoscience with biomedical application has seen its own bottlenecks and hinderances such as unwanted biological toxicity of the metal nanoparticles, interference with cellular functioning and physiology, undesirable modification of protein structure and function, role in gene regulation. There are indeed several challenges such as aspects related to the synthesis of nanoparticles, size and distribution properties, cellular interactions, toxicology, nutrition, biomimetics, environmental safety, etc.

Some solutions have recently surfaced such as green chemistry based design, synthesis, of nanoparticles based on plant extracts and microorganisms and application of environmentally safe and biologically lesser toxic, biodegradable nanoparticles [7]. Such nanoparticles with properties of low molecular weight and larger structures function as an effective drug delivery vehicles with high degree of biological compatibility.

Some of the emerging fields of nanomedicine include nano diagnostics, theranostics, nano oncology and nanoinfectiology with most of the research taking place in Americana and European countries [8]. In conclusion it can be said that nanomedicine holds

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great promise and relevance in the forthcoming decades where a big leap in cost effective and efficient treatment treatments can be expected particularly for detecting and curing cancer at early stages.

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