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Nanomaterials in Human Health Care

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Abstract: *Nanomaterials are similar in scale to biologic molecules and systems and therefore they can be engineered to have various functions potentially useful for medical applications. Nanomaterials are at the leading edge of the rapidly developing field of nanotechnology. Their unique size-dependent properties make them potential candidates for health care activities in this article a brief report is presented about the properties of nanomaterials and their utility in diagnosis and therapy of diseases coming in the way of human health. The application of nanomaterials for stem cell treatment in due course time is also mentioned.*

Keywords: *Nanobiotechnology, Nanoparticles, Nanomedicine, Nanotechnology*

1. Introduction

The word 'nanos' in Greek means dwarf [1, 2]. Generally the materials of the size between 1 to 100 nm [3] are called as nanomaterials. Nanotechnology dates back its existence around 2000 years ago and was in use as sulfide nanocrystals for hair dyes and gold nanoparticles for coloring glass by ancient Greek and later by Romans [1, 2]. Feynman first presented the modern concept of nanotechnology in 1959 [1]. Smalley who was awarded with Nobel Prize in chemistry for the discovery of a new carbon nanotube. [2].

2. Properties of Nanomaterials

Generally nanomaterials consist of metallic, non metallic, organic, or semiconducting particles. The surface of nanomaterials is usually coated with polymers or biorecognition molecules for improved biocompatibility and selective targeting to biologic molecules. The ratio between the surface area and volume of the nano materials is approximately the same as macroscopic materials. [4]. Nano particles are tunable for their electronic, magnetic and optical properties due to their spin and selection of quantized energy levels. The larger magnetic field due to nano materials (spin component) increases the contrast in Magnetic resonance imaging (MRI). The Size-dependent energy difference produces fluorescence emissions of Quantum dots of different sizes. Furthermore, the magnetic and optical signals from these inorganic nanomaterials tend to be stronger than their traditional molecular counterparts because a larger number of electrons are involved.

3. Nanomaterials as Diagnostic Candidates

Multifunctional nanoparticles for diagnosis (quantum dots, magnetic, metallic, polymeric and silica nanoparticles) and/or therapy (magnetic and metallic nanoparticles) work as promising materials. They safely carry the drug to deliver at the specified target site. [5-9].

The conventional nano particles in the diagnosis are Gold nanoparticles, Magnetic nanoparticles, Quantum dots (QD) and DNA-protein and nanoparticle conjugates. The variation in the absorption spectra due to vatriation in the sizes of the gold nanoparticles exhibits a change in the color [10]. Gold nanoparticles find misapplications in the four prominent areas labeling, delivery, heating and detection [11]. Incorporated sufficient amounts of super paramagnetic iron oxide nanoparticles into cells, enable their detection with good resolution in Magnetic Resonance Imaging (MRI) [12]. The magnetic nanoparticles use as hyperthermia agents deliver good amounts of thermal energy to the targeted bodies such as tumors [13] for curing. Quantum Dots (QDs) are semiconductor nanocrystals characterized by high photo stability, single-wavelength excitation, and size-tunable emission. QDs possess favorable electrical and nonlinear optical properties. QDs find applications as molecular diagnostic tools for Cancer, Genotyping, Whole blood assays, DNA mapping, Immunoassays, antibody tagging and the detection of pathogenic microorganisms, DNA protein and nanoparticle conjugates act as inorganic fluorophores in the detection of immunological assays [14]. Nanochips separate DNA probes to specific sites on the array based on charge and size. Once these probes are on specific sites of the nanochip, the test sample (blood) can then be analyzed for target DNA sequences by hybridization with these probes. The DNA molecules that hybridize with target DNA sequences fluoresce, which is detected by the chip itself [15]. Microfluidics (Lab-on-a Chip) systems, analyses the unknown DNA samples [16] with sophistication. Micro electromechanical systems (MEMS) are related to micro fluidic systems. MEMS are primarily used in drug-delivery into human systems for diagnosis and therapy. The swallowed capsule technology of MEMS allows the doctors to visualize functionality of organism inside the human system such as GI bleeding. [17]

Nanomaterials are used to either simplify the readout or amplify the detection threshold of the diagnostic devices. Nanoparticles are used in lateral-flow in vitro diagnostic assays (LFA) such as the urine pregnancy test for detecting protein markers [18]. Gold nanoparticles are also used in genomic detection and mutations with a sensitivity similar to that of PCR-based assays [19, 20] A number of approved LFAs for measuring human immunodeficiency virus (HIV), malaria, and cardiac markers are also available. A bio-barcode assay is currently being is used for the detection of proteins found in prostate cancer. [21]

4. Nanoparticles in Imaging Mode

The spectroscopic nature and high resolution imaging capabilities of light permits to characterize biological morphology and function at molecular and cellular levels [22]. Some of the important imaging techniques are Molecular imaging, optical imaging, fluorescence imaging, OCT, multimodal imaging, positron emission tomography. Several different NP designs using light-sensitive novel imaging agents have been developed. [23, 24] to identify and characterize various fundamental processes at the organ, tissue, cellular and molecular levels. Gold and iron oxide and polypyrrole NPs have been frequently used as OCT contrast agents [25, 26]. PLGA polymeric NPs are used to encapsulate various fluorescent dyes for cellular imaging [27]. [Gold nanomaterials are commonly used for photoacoustic computed tomography as well. [28]. Nanomaterials like emissive conjugated polymer (PFVBT) are used in the dual imaging system in vivo for fluorescence and MRI to detect tumors [29].

5. Nonomaterials for Therapy

Some important areas of nanomaterils like cancer, neurological disorders, cardiovascular diseases, infections and stem cell used in therapeutic use in human health care are very briefly mentioned.

The potential benefits of nanoparticle in the treatment of cancer are highly selective and rapid tumor destruction with minimal damage to surrounding healthy tissue. Additionally, this therapeutic technique may be used in combination with chemotherapy and radiation [30] increases the effectiveness of therapy. Nanomaterials are delivered as a specific structure, or combination of structures, designed to deliver the therapeutic effect, directly to the site, requiring a much lower dose for neurological disorders in central nervous system [31, 32]. In clinical cardiology, Nanoprobes are employed for detection and management of stenosis problems due to plaques [33]. The bactericidal properties of nanoscale formulations [34] such as magnesium oxide (MgO) and calcium oxide (CaO) carry active forms of halogens which destroy microbes effectively without toxicity or harmful residual. Nanofibrous scaffolds mimic the architecture of extracellular matrix (ECM) which is considered as a good candidate matrix for cell delivery in tissue engineering applications. [35]. Stem cell therapy with Nanomaterials are raising positive hopes in the human minds to get relieved from the complicated and difficultily curable diseases.

6. Conclusions

The nanotechnology will help to improve health by enhancing the efficacy and safety of nanosystems and nanodevices. Nanomaterials with its potential application to improve health condition. It is possible for, early diagnosis and in the treatment of cancer, heart diseases, diabetes and other anticipating diseases. In the coming years, nanotechnology will play a key role in the medicine providing revolutionary opportunities for early disease detection, diagnostic and therapeutic procedures to improving health and enhancing human physical abilities. Procedures and provisions for cell-material interactions, scaffolds for tissue engineering, and gene delivery systems provide innovative opportunities in the fight against incurable diseases. Nanotechnology may fundamentally transform science, technology, and society offering a significant opportunity to enhance human health in novel ways, especially by enabling early disease detection and diagnosis, as well as precise and effective therapy tailored to the patient.

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