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ADVANCED NANOMATERIAL STUDIES FOR LIFE SCIENCES AND MEDICAL APPLICATION

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Abstract:

The Nanomaterial's have been widely studied from many years due to wide variety of potential application in biomedicine and other fields. The Nanotechnology provides an opportunity to develop new functional materials with vast potential in many areas. The role of nanotechnology in development of specific drug delivery systems, Polymeric nanoparticles, lipid Nano systems, and The Nano systems are described with special emphasis on targeted drug delivery in cancer therapy also. Nanotechnology is an industrial revolution based on integration of disciplines that could change human life.

Keywords: Nanoparticles, Drug delivery, lipid Nano, Diagnostic, Polymers Tissue Engineering.

Introduction:

The nanotechnology was actually known from very famous scientist Richard Feynman, he is a famous physicist gave this idea in his lecture given at California Institute of Technology called "there is plenty of room at the bottom". He presented a technological vision of miniaturization of materials, manipulating and controlling at Nano scale called Nanotechnology [1]. The work at the atomic and molecular levels to create a materials, structures, devices and systems has new properties [2]. The nanotechnology is to describe the materials, devices and systems with structures and components exhibiting new and significantly improved physical, chemical and biological properties. The phenomena and processes enabled by the ability to control properties at Nano scale [3, 4]. The Nanotechnology has role to build Nano-object, atom by atom and molecule-by-molecule [5]. The changes in properties are due to increase in surface to volume ratio and dominance of quantum effects which is associated with very small sizes and large surface area. The Copper which is opaque at macro scale becomes transparent at Nano scale because at Nano scale properties of material become size

dependent [6]. The platinum which is inert becomes a catalyst at Nano scale [7]. Otherwise stable aluminum is combustible [8]. There are two fundamental approaches at Nano scale one is Top down approach and second is Bottom Up approach. The Top down approach is the production of nanostructures materials by taking bulk material and forming it into desired structure which include development of integrated circuits (ICs). "Bottom-up" is the building up nanostructures atom-by-atom [9] i.e., quantum dots and nanotubes.

Nanomaterial's For Drug Delivery:

There are many potentially useable prospects in nanotechnology for drug delivery systems. Some of the advantageous areas in which nanotechnology efforts are being made include vaccine adjuvants and delivery systems [10].The mechanisms of the biological and physical world operate mainly at the range of 1 to100 nm. The diameter of a hydrogen atom is about 0.1 to 1nm. A molecule may be made up of 20 to 30 atoms and has a diameter of about 1 to 10 nm. The width of a DNA molecule is about 2.5nm, a typical protein is between 1 to 20nm and ATP biochemical motor is 10 nm in diameter [11]. The viruses that attack human cells fall within 10 to 200 nm, which is within the nanometer region [12]. Nature itself has nanotechnology those producing nanostructures that offer functional proteins and many other compounds at cellular level of great significance to life on earth [13]. The DNA molecule can be seen as a self-assembly machine which replicates itself and also produces complex organisms under the right conditions. Ribosomes construct protein molecules with precision following instructions from DNA [14]. By knowing the principles of natural systems would enhance the design and fabrication of nanostructures that may mimic the functions of natural systems. The biomolecules such as proteins, peptides, DNA, lipids and carbohydrates can act as templates their shapes and chemical properties can be used to arrange inorganic substances such as metals on Nano scale [15]. The researcher presently seeks systematic approaches to fabricate man-made objects at Nano scale and to incorporate nanostructures into macrostructures as nature does [16]. The controlled release drug delivery system or delivery vehicles that enhance circulation and targets of drug and to specific cells, systems that improve the solubility of poorly water soluble drugs [17]. These approaches and concept which may differ from the living systems in aqueous medium as self-assembly of atomic and molecular structures on other nanostructures, interaction on surfaces of various shapes, self repair and integration on multiple length scales may be utilized as model

Nanoparticles in polymer:

Polymer drugs are used as drug delivery systems because many pharmaceuticals are not soluble in water, inefficiency towards specific target site [18]. The polymeric nanoparticles can be prepared from synthetic. The polymeric materials are either biodegradable or non-biodegradable, but should be essentially biocompatible. Poly D, L- lactide-co-glycolide, poly epsilon-caprolactone, poly alkyl cyanoacrylates, poly styrene-co-maleic anhydride, poly di-vinyl ether-co-maleic anhydride, poly vinyl alcohol, and poly ethylene glycol are some of the synthetic, non immunogenic polymers extensively used for preparation of nanoparticles [19]. The poly amino acids, hyaluronic acid, albumin, dextran, chitosan, and gelatin are few examples of the natural biodegradable polymers. While each of the polymers poses its own advantages. The nanoparticles can be synthesized with high degree of reproducibility from majority of them, natural polymers, due to their natural origin, non-toxicity and biodegradability. The advantage of synthetic polymers remains the possibility to synthesize them reproducibly with well-defined physico-chemical properties helping the natural polymers to overcome this drawback and we can expect a surge in delivery systems based on them. These polymeric nanoparticles can be administered into the systemic circulation which will be essentially removed within an hour of administration by the macrophages of the reticulo-endothelial systems. The poly ethylene oxide are very popular for surface modification of Nano particulate drug delivery systems since they have long history of safe use in biological and pharmaceutical products [20]. Surface-bound poly ethylene glycol chains extend into the aqueous physiological environment and repel proteins, decrease antibody formation, and increase the circulation of the formulation in the plasma for extended periods of time by the steric repulsion mechanism.

Nanotechnology for lipids:

The Nano science is an emerging science which is widely expected to provide solutions on various problems. The Nanomaterial's in biotechnology which finds applications in various fields like electronics, materials, environment, metrology, robotics, healthcare, information technology, pharmaceutics, agriculture, transport etc. [21]. Nanotechnology is considered as a relatively young field, with tremendous potential to reinvent existing industries and significantly improve standards of living. In drug carriers the liposomes are the most extensively studied and possess the most suitable characteristics for protein encapsulation. Liposomes are the concentric spherical phospholipid bilayers encapsulating in an aqueous space. These are the particles which are completely biocompatible biologically inert and cause very little toxic. Their inner aqueous compartment is generally used for encapsulation of peptides and proteins. Many techniques for liposome preparation require only manipulations that are compatible with maintaining the drug integrity [22]. The have developed long-

circulating poly ethylene glycol modified liposomes linked with HIV-1 Tat-peptide for efficient DNA delivery in vitro and in vivo in tumor models. However, as with other Nano particulate delivery systems, conventional liposomes suffer from rapid elimination from the systemic circulation by the cells of the reticule endothelial system (RES). For making of liposomes capable for delivering pharmaceutical agents to targets, attempts were made to prolong their circulation in lifetime. This was achieved with the development of surface-modified long circulating liposomes grafted with a flexible hydrophilic polymer, such as PEG or PEO. These are the most common examples of polymers which prevent plasma protein adsorption of nanoparticle surface and the consecutive recognition and uptake of liposomes. It has been shown with a broad variety of examples that, similar to macromolecules, liposomes are capable of accumulating in tumors of various origins via the EPR effect [23]. The form of Liposomal are the two conventional anticancer drugs, daunorubicin and doxorubicin, are currently used in the clinical practice. Liposomal doxorubicin, incorporated into long circulating PEG-coated liposomes, demonstrates excellent effects in EPR-based tumor therapy and diminishes the toxic side effects of the original drug.

Nanomaterials in Diagnosis and tissue Engineering:

The recent developing and revolutionary area of nanotechnology is molecular diagnostics which requires small amount of sample, less time, quick process and reliable for different kinds of analysis Companies are working harder to synthesize new chip analyzers require only Nano gram or Pico liter sized samples which gives more scope for efficient analysis and reliability [24]. Tissue engineering is the interlinked between pharmaceutical and biomedical sector where nanotechnology will have real impact on life science. In developed countries, this field growing rapidly in terms of commercial importance. The nanotechnology can be used to grow tissues & organs artificially on Nano patterned scaffolds, Medical devices include contact lenses require surface topography measurement at the Nano level to verify shape and intended optical profiles using nanostructured materials and functionalized surfaces [25]. In cases of particular tumors, the delivery systems with smaller sizes, such as peptide (protein)/polymer conjugates or drug-loaded micelles should be more efficiently use. The use of specific "vector" molecules can further enhance tumor targeting of peptide/protein carriers or make them EPR effect independent. The important for the cases of tumors is immature vasculature, such as tumors in the early stages of their development, and for delocalized tumors. The deliveries of peptide and protein anticancer pharmaceutics, Self-assembled Nano systems for targeting subcellular organelles, such as the mitochondria, are also developed. It is observed that the mitochondrial dysfunction contributes to a variety of human disorders. The recent developments in mitochondrial research and increased pharmacological and pharmaceutical efforts have lead to the emergence of Mitochondrial Medicine

[26]. In-vivo testing devices or sensors which can be used to detect cancer, infections and coronary heart attacks and small transmitters are used to communicate with outside world and tell patient is at particular risk at that time. Miniaturization is the key to these applications, combining sensors and actuators with Nano scale features to produce personal health devices.

Conclusion:

The different aspects of nanotechnology brings the science almost incomprehensibly small device close and closer to reality and at some point developments will be so vast that they will affect all fields of science and technology. Although expectations are too high but safety of Nano medicine is not yet fully defined. Polymeric nanoparticles, lipid Nano systems that include liposomes and Nano emulsions, and self-assembling Nano systems such as micelles offer tremendous opportunity for development of site-specific delivery systems for drugs and genes. These delivery systems are especially critical in an era of rising healthcare cost and development of multidrug resistance in cancer and infectious diseases.

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