The New Field of the Nanomedicine

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Abstract

The nanoscience and nanotechnology nowadays are present in many areas of our life, and they will have much impact on the fields of medicine and health care. The world of medicine is very complex, so all of the benefits from nanoscience and nanotechnology to medicine will take time to become evident; however, other benefits will come immediately. The tools of research and medical practice will be less expensive and more powerful. The research and development of new devices as well as the diagnostics will become, more effective, enabling faster response and the ability to treat new diseases. Small sensors, drugs, disease labels and indicators, computers, implantable devices, diagnostic equipment will continuously monitor health, at low cost, and automatic processing will be possible. Many new types of treatment can be addressed, while the medicine cost will go down, treating diseases more safely, and the benefits will be experienced by many more people around the world.

Keywords: nanoscience, nanotechnology, nanomedicine, nanotoxicology

Introduction

The emergence of nanoscience and nanotechnology in the health sciences has led to a new discipline called nanomedicine, whose main objective is to develop new tools and diagnostic research to prevent and treat diseases. Nanotechnology is considered an emerging technology due to the possibility to advance well established products and to create new products with totally new characteristics and functions having enormous potential in a wide range of applications. In addition to various industrial uses, great innovations are foreseen in information and communication technology, biology and biotechnology, medicine and medical technology [1]. Nanomedicine is a research area with potential to shape, direct, and change the future of medical treatments in a revolutionary manner over the next decades. While the common goal with other fields of biomedicine is to solve medical problems, this area embraces an increasing number of technology platforms as they become miniaturized [2].

Nanomedicine studies nanoscale interactions and it uses devices, systems, and technologies that include nanostructures that can interact at molecular, micro, or cellular level. One of the major challenges in this process is the research and development of "nanotherapies", specifically targeting of diseased tissues and organs, this method can prevent surrounding damage to healthy cells and therefore avoiding the dreaded side effects of current treatments. Nanomedicine promises to solve some of these major challenges by the ability of early detection of disease (such as cancer) or the ability to regenerate organs and tissues that are damaged. Nanomedicine includes three main areas: nanodiagnosis, controlled drug release (nanotherapy) and regenerative medicine. Nanodiagnosis is the development of systems and image analysis to detect a disease or cellular malfunction. The Nanotherapy purports to address active nanosystems containing recognition elements to act or transport and release drugs exclusively in cells or affected areas in order to achieve a more effective treatment while minimizing side effects. Regenerative medicine aims to repair or replace damaged tissues and organs using nanotechnology tools.

The field of nanomedicine is the science and technology of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body. The application of nanotechnology to medicine raises new issues because if new uses are allowed, it can contribute to the development of a personalized medicine both for diagnosis and therapy [3].

Nanomedicine

Many diseases originate from alterations in biologic processes at molecular or nanoscale level. Mutated genes, misfielded proteins, and infections caused by viruses or bacteria can lead to cell malfunction or miscommunication, sometimes leading to life threatening diseases. These molecules and infectious agents are nanometers in size and might be located in biological systems that are protected by nanometer-size barriers. Nanotechnology is defined as the intentional design, characterization, production and application of materials, structures, devices, and systems by controlling their size and shape in the nanoscale range. Because nanomaterials are similar in scale to biological molecules and systems, yet can be engineered to have various functions, nanotechnology is potentially useful for medical applications. The field of nanomedicine aims to use the properties and physical characteristics of nanomaterials for the diagnosis and treatment of diseases at the molecular level [4].

Nanomedicine is the branch of nanotechnology and nanoscience that would allow the ability to cure disease from inside the body and at the cellular or molecular level; it is one of the most promising fields within the potential new technological advances in medicine. This technology is revolutionizing medical areas such as monitoring, tissue repair, diseases evolution control, protection and improvement of human biological systems, diagnosis, treatment and prevention, pain relief, health prevention, delivery of drugs to cells, etc., these subjects positioning it as a revolution in the medical scientific and healthcare fields. Nanodiagnostics based on molecular detectors, biosensors, fluorescent nanoparticles, nanopore sequencers of individual genomes, nanoparticles as containers for drugs and vaccines, nanoparticles drugs, synthetic genomes as self-reproducing systems, organs and tissue repair nanomaterials, nanorobots that find pathological lesions in tissue and correct them, devices that mimic functions of various cells, etc. All are certain achievements of nanotechnology applications in medicine [5]. Among the most significant scientific advances are biosensors, new ways to deliver drugs more direct, effective treatments and new implant materials. Nanotechnology is of great use for medical diagnosis and various nanoparticles that have exhibited tremendous potential for detecting disease markers, pre-cancerous cells, fragment of viruses, specific proteins, antibodies and other indicators of a specific disease [6]. It is an emerging branch of science for designing tools and devices of nanoscale size with specific function at the cellular, atomic and molecular levels. The concept of employing nanotechnology in biomedical research and clinical practice is best known as nanomedicine. This is an upcoming field that could potentially make a major impact to human health. Nanomaterials are increasingly used in diagnostics, imaging and targeted drug delivery. Nanotechnology will assist the integration of diagnostics/imaging with therapeutics and facilitates the development of personalized medicine, prescription of specific medications best suited for an individual treatment [7].

The aim of nanomedicine may be broadly defined as the comprehensive monitoring, control, construction, repair, defense and improvement of all human biological systems, working from the molecular level, using engineered devices and nanostructures, ultimately to achieve medical benefits. In this context, nanoscale should be taken to include active components or objects in the size range from one nanometer to hundreds of nanometers. These may be included in a micro device (that has a macrointerface) or in a biological environment. The focus, however, is always on nanointeractions within the framework of a larger device or directly within a sub cellular (or cellular) system [8].

Humans have always tried to improve their health condition and lifestyle. Nowadays, there are numerous drugs and medical technologies that can treat conditions that only a few decades ago were deadly, like:

- Nanoparticles that kill cancer cells.
- Nanoparticles for help regenerate bones.
- Fluorescent nanoprobe.
- ID Tumors noninvasively.
- Implants that minimized the risk of adverse events.
- Ultrasound to penetrate bone.

- Nanoparticles to monitor cancer and other diseases.
- Targeted cancer therapy.
- Imaging ID's receptors.
- Technology to improve lung cancer detection.
- Imaging tricks to observe Alzheimer’s development.
- New methods to treat tumors with antennas.
- Genomics and truly personalized medicine.
- Body sensors.
- Medical recorders and portable diagnostics, etc.

Medical advancements have not just been limited to treatment of diseases. Reconstruction of injured body parts is now possible through innovative biomaterial and implants, and tissue engineering is opening the possibility to recreate organs from cultures of stem cells. Nanotechnologies are already playing an important part in modern medical diagnosis and treatment technologies, and are opening new venues for future developments [9].

Applications of nanotechnology to medicine are already underway and offer tremendous promise; these applications often go under the moniker of nanomedicine or, more generally, bionanotechnology. Two areas in which the impacts of nanomedicine are likely to be most significant are: first, diagnostic and medical records and second, treatment, including surgery and drug delivery [10].

Nanoscience and Nanotechnology have an enormous potential, and a bright future with multiple applications in many areas like engineering, optics, energy, consumer products, nanomedicine (superior diagnostic, therapeutic and preventive measures).Nanomedicine is already a reality that is producing advances in diagnosis, prevention and treatment of diseases because, among other reasons, to interact with the biomolecules (proteins and nucleic acids). In addition, this capability will enable a better understanding of the complex regulatory and signaling pathways that direct the behavior of normal and transformed cells. Cells within tissue derive mechanical anchorage and specific molecular signals from the insoluble extracellular matrix that surrounds them. Understanding the role of different cues that extracellular matrices provide is critical for controlling and predicting called responses to scaffolding materials, these complex systems present multiple kinds of cues including mechanical and topographic features, and multiple adhesive ligands on the same molecule [11]. Hence understanding these cues are important to design new medical applications, and to understand cellular behavior not only for tissue engineering or implants.

Certain fields are particularly interested in nanotechnology, especially:

- Monitoring (images).
- Tissue repair.
- Evolution control of diseases.
- Protection.
- Improvement of human biological systems.
- Diagnosis.
- Treatment.
- Prevention.
- Applying drugs directly to the cells.

With the use of nanotechnology, scientists hope to prevent illnesses; more quickly diagnose with fewer side effects, and create better medical aids, such as more compatible prosthetics. Nanoparticles and surfaces made of nanostructures are used in many areas of healthcare research [12]. Nanoparticles have shown promising applications from diagnosis to treatment of various types of diseases, including cancer. The applications of nanostructured materials such as nanoparticles, quantum dots, nanorods, nanowires, and carbon nanotubes in diagnostics, biomarkers, cell labeling, contrast agents for biological imaging, antimicrobial agents, drug delivery systems, and anticancer nanodrugs for treatment of cancer and other infectious diseases are growing [13].

Nanotechnology has had tremendous impact on medical science and has resulted in phenomenal progress in the field of drug delivery and diagnostics. A wide spectrum of novel nanomaterials including polymeric particles, liposomes, quantum dots, and iron oxide particles, have been developed for applications in therapeutic delivery and diagnostics.

This has resulted in control over the rate and period of delivery and targeting of drugs to specific organs in human body. The size, choice of polymer, surface chemistry, shape and mechanical properties of the particles are parameters that critically affect particle function. Numerous biomaterials and fabrication techniques have been developed in the last decade that focus on novel design parameters, such as shape and mechanical properties and the interplay of these parameters with size and surface chemistry of particles. Recent advances with particular focus on the importance of particle shape are highlighted, and the challenges that are yet to be fulfilled are underscored [14]. Although considerable advances have already been made in understanding how the physical properties of materials affect biological functions, the field is still in its infancy. At present, it is clear that physical properties, such as size, shape, mechanical properties, surface texture and compartmentalization, profoundly impact the function of a biomaterial, once it is placed into a biological environment. Many other physical parameters including density and porosity will also significantly impact a material's function. This greatly widens the design parameter space for the next generation of biomaterials but, at the same time, raises important questions. Substantial work remains to map the dependence of biological response to physical properties and to categorize the relative weight of different physical and chemical factors. For each biomedical application, detailed mechanisms of how physical properties affect biological performance, as well as the interplay among various physicochemical properties, may have to be elucidated case by case [15].

Drug Delivery

Nanoparticles drug delivery systems seem to be a viable and promising strategy for the pharmaceutical industry. They have advantages over conventional drug delivery systems. They can increase the bioavailability, solubility and permeability of many potent drugs which are otherwise difficult to deliver orally. Nanoparticles drug delivery systems will also reduce the drug dosage, frequency and it will potentially increase the patient compliance. In near future, nanoparticles drug delivery systems can be used for exploring many biological drugs which have poor aqueous solubility, permeability and less bioavailability. Nanoparticles can minimize some of these drugs uncommon problems by safeguarding stability and preserving their structure. In addition, nanoparticles provide ingenious treatment by enabling target delivery and controlled release [16].

To successfully integrate a drug into a nanoparticle, several design strategies can be explored, including physical complexion with hydrophobic drugs, or covalent bonding with cleavable linkages for intracellular release. Drugs loaded through hydrophobic interactions are typically encapsulated within the nanoparticle coating, limiting nonspecific cell interaction. This approach is advantageous in applications where a drug being delivery and could seriously harm non targeted tissue [17]. Process in understanding the nanoparticle internalization by a variety of mammalian cells has already allowed the design of effective nanomedicines, especially for the treatment of infectious diseases and some cancers [18].

Drug delivery strategies are a growing area of research. Rather than focusing on finding new molecular targets and pathways in autoimmune diseases, drug delivery strategy can provide the tissue selectivity with current therapies by altering their pharmacokinetics and biodistribution. Nanocarries have been demonstrated to have potential in improving the safety profile and therapeutic efficiency of the current therapies for autoimmune diseases, particularly for those with potent but toxic compounds [19]. Inorganic nanomedicine holds great promise in diagnostics, drug and gene delivery, sensing and biosensing, and *in vivo* imaging under the present scenario. Smartly engineered inorganic nanoparticles can boost drug efficacy and can improve drug targeting to specific areas in the body, therefore making treatment less toxic and less invasive [20].

Medical Devices

With the amazing advances in the preparation and characterization techniques of nanotechnology products, the possibility of manufacturing devices capable of establishing and intimate interaction with the biological world has been opened. This fact represents a precise control over the processes of therapeutic substances release, and means an opportunity to improve the specificity of the therapeutic action, as well as to reconsider some of the drugs for certain diseases that were once discarded because of their low levels of tolerance [21]. Dendrimers are a novel class of nanoscale carriers that can be multifunctional used for medical applications like targeting, imaging and treatment. These molecules have internal cavities used to encapsulate hydrophilic or hydrophobic drugs to control the release rate, or the imaging and targeting properties of these drugs. The molecule could be functionalized with various drugs, ligaments or fluorescence tags [22].

The tailorable dendrimer surface chemistry and various bioconjugation techniques allow one to design various complex dendrimer medical devices for different medical applications. These molecules are recognized as powerful nanoplatforms for biological nanotechnologies on medical treatments, diagnostics, monitoring and control of biological systems [23]. Nonomedicines aim to deliver drugs and imaging agents more efficiently and more specifically to pathological sites. A significant amount of evidence has been obtained over the years exemplifying the superiority of nanomedicine formulations over free drugs, both at pre-clinical and at clinical level. The submicrometer sized carrier materials are designed to modulate the pharmacokinetics and the biodistribution of conjugated or entrapped chemo – therapeutic drugs [24]. All of these developments and advances at the moment are used in the development of medical devices or microdevices. Microdevices are those that are fabricated with the aid of technologies such microfabrication, surface pattering, and microfluidics, and are often integrated with cell and tissue cultures. Advances in methods of microdevice fabrication and application could address changes faced in nanomedicine. Microdevices are generally economical, reproducible, and readily amenable to modification and redesign [25].

Implants and Tissue Engineering

With the increase of the world's population, the demand for medical-implants, tissue-repair or organ-replacement increase too. Current medical alternatives to these areas offer tremendous opportunities because they cannot satisfy the required patient quality. For this reason, today, there has been an exponential increase in studies using nanotechnology for tissue engineering applications, organs, and implants.Nanotechnology, or the use of nanomaterials, may have the answer, since only these materials can mimic the surface properties (including topography, energy, etc.) of natural tissues.Currently, one promising and widely investigated approach to the design of biomimetic materials-capable of eliciting specific cellular responses and directing new tissue formation by bimolecular recognition of the materials by the cell, is achieved by incorporating cell binding peptides in the form of a native long chain extracellular matrix via chemical or physical modification [26]. Over the last decade, nanomaterials have been highlighted as promising candidates for improving traditional tissue engineering materials [27].A rapidly evolving discipline, vascular tissue engineering provides a novel technology to produce tissue engineering vascular grafts which incorporate into host blood vessels and potentially solve the problems associated with conventional vascular grafts. As our understanding of the mechanisms underlying graft remodeling expands, the application of nanomedicine continues to hold great promise in the design of next generation of Vascular Tissue Engineering grafts [28]. Biomedical application has been a primary driver in establishing the science of biocompatible and biodegradable polymers. Tissue engineering has attracted a great deal of attention, because of its potential as a new method in the treatment of damaged or lost human tissue and organs. In tissue engineering, scaffolds play an important role by serving as substrates for bone regeneration, cell attachment, and physical supports for the formation of new tissues [29].

The new advances in nanomedicine have created novel materials for use in chemistry and biology. Today we can simulate the nanometer dimensions of biological components of our body, and this new development direction will be give us more effective implants, scaffolds, tissues and organs. Ground-breaking advances in nanomedicine (defined as the application of nanotechnology in medicine) have proposed novel therapeutics, which can potentially revolutionize current medical practice [30]. Artificial organs are an example of a medical nanodevice, an artificial kidney is a membrane device, mainly dialyzer, which is capable of cleaning the blood of patient with chronic kidney diseases. Likewise, a blood oxygenator is used outside the body during surgery for oxygen transfer to, and carbon dioxide removal from the blood. The bioartificial liver is a bioreactor which performs the liver functions of patients in liver failure, by using liver cells [31].

Diagnostic

Nanodiagnostics will improve the sensivity and integration of analytical methods to yield a more coherent evaluation of life processes. An important benefit would be extension of present limits of molecular disgnostics. Nanoparticles are the most versatile material for developing diagnostics. Nanotechnologies enable the diagnosis at single cell and molecule-level, and some of these can be incorporated in the current molecular diagnostics such as biochips. Nanoparticles, such as gold nanoparticles and quantum dots, are the most widely used, but various other nanotechnologies for manipulation at nanoscale as well as nanobiosensors are reviewed. These technologies will extend the limits of current molecular diagnostics and enable point-of-care diagnosis as well as the development of personalized medicine [32].

This will have applications in genomic analysis, proteomics, and molecular diagnostics. Nanotechnology has potential advantages in aplications in point-of-care diagnosis, like at the patients, bedside, self diagnostics for use in the home, and for field use of sensors. Novel methods to manage the symptoms of cancer that adversely impact quality of life and research tools that will enable rapid identification, as well as validation of new targets for clinical development and prediction of drugs resistance. Some nanotechnologies with potential application in molecular diagnostics are Nanochip, Nano-arrays, Nanoparticles (Gold NP), NanoBarcodes, Quantum dot, Nanowires, Nanopores, DNA nanomachines, Nanosensors, Resonance light sacttering, etc [33].

Detecting or intervening in biomolecular processes for medical diagnostics, drug delivery, and bacterial inactivation requieres a functional probe which interfaces not only the targeted biomolecules but also provedes an external stimulus. Metal nanoparticles serve as such functional probes. Key challenge is the ability to tailor the size, composition, surface and magnetic properties for a controllable biomolecular recognition, biocompatibility, toxicity, transduction, and intervention. Gold or Silver base nanoparticles enable effective biomolecular recognition, biocompatibility and transduction, which, upon introducing a magnetic component as the core, impact intervention capability and reduced toxicity [34].

Together, these insights indicate the noninvasive in vivo imaging can contribute substantially to realizing the potential of tumor targeted and personalized nanomedicine, not only by preselecting patients in early phase clinical trials, but also by allowing for individualized and optimized chemotherapeutic interventions once given nanomedicine formulation has been approved for clinical use. Consequently, incorporating both drugs and imagine, agents within a single nanomedicine formulation, and using the information that can be obtained with theranostics formulations to predict how well individual patients will respond to a particular tumor targeted intervention, seems to be one of the most important and one of the most promising paths toward personalize nanomedicine [35].

Cancer Treatment

Once cancer has been diagnosed, treating the disease mostly relies on surgery, radiotherapy and chemotherapy, separately or in combination. Nanotechnology represents a great hope to improve cancer treatments by acting at least at two main levels: conferring new properties to a pharmaceutical agent (increased stability, modified pharmacokinetics, decrease toxicity) and targeting the agen directly to the tumor [36]. Nanomedicine techniques are conceptually for cancer treatments, which involve acute doses of potent drug where overall exposure is a balance of inherent drug toxicity against short administration timescales. Anticancer chemotherapies attempt to target directly to tumors by controlling nanoparticles size to allow diffusion through leaky tumor vasculature but prevent delivery through normal tight blood vessels into healthy tissue. Highly potent and highly toxic drugs may therefore be preferentially conveyed to the site of action, minimising non specific damage and mitigating toxicity [37].

The immune system has ability to recognize and kill pre-cancer cells and cancer cells, however, despite the immune system, surviving tumor cells learn how to escape the immune system after immunoselection. Cancer immunotherapy develops strategies to overcome these problems, Nanomedicine applications in cancer immunotherapy include the nonodiagnostics and Nanobiopharmaceuticals [38].

Even though our knowledge of cancer disease, it has increased, it is still a major health issue around the world, and it continue killing people. With the recent reseach results, gold nanoparticles are a promising candidates for detetion, drug delivery, and therapeutic treatment for cancer. This metal is suitable for use in biological systems based on its nanoscale properties. Gold nanocages represent a new class of ideal nanomaterials for a variety of aplications in nanomedicine due to their unique properties and multifunctional nature. Great progress has been made in this field in recent years like:

- Optical tracers
- Contrast agents for various imaging
- Diagnostic modalities
- Kill cancer cells through the photothermal effect
- Load and release drugs in controlled manner [39].

Nanotoxicology and Nanomedicine

Nanomedicine refers to highly specific medical interventions at the molecular scale for curing disease or repairing damage tissue, nanomedicine is define as the monitoring, repair, construction, and control of human biological system at the cellular, molecular, and atomic levels using engineered nanodevices and nanostructures [40]. It can be subdivided in to five fields by the European Science Foundation (ESF):

- Analytical tools,
- Nanoimaging,
- Nanomaterials
- Nanodevices
- Novel therapeutics and drugs delivery systems
- Clinical
- Regulatory and toxicological issues.

Nanomaterials have the potential to revolutionize medicine because of their ability to affect organs and tissue at molecular and cellular levels. Current research is focused on the medical applications of nanotechnology, whereas side effects associated with their use, especially the environmental impacts of their manufacture and disposal, are generally not taken in to consideration during the engineering process. Incorporating environmental concerns into nanomaterial engineering and nanomedicine development is important, but it greatly increases decision complexity [41].

The basic procedures and rules for oversight of United States human subject research have been in place since 1981. Certain types of human subject research, however, have provoked creation of additional mechanisms and rules beyond the Department of Health & Human Services (DHHS) Common Rule and Food and Drug Administration (FDA) equivalent. Now another emerging domain of human subject research nanomedicine is prompting call for extra oversight. However, in 30 years of overseeing research on human beings, we have yet to specify what makes a domain of scientific research warrant extra oversight. This failure to systematically evaluate the need for extra measures, the type of extra measures appropriate for different challenges, and the usefulness of those measures, hampers efforts to respond appropriately to an emerging science such as nanomedicine [42].
Development of specific in vitro assays that can be validated for nanomaterials is to be applauded, but the establishment of meaningful, high-throughput screening-especially in the context of safe evaluation that can be optimal for all nanomaterials. For each nanomedicine, it is essential to choose a specific portfolio of test and assays, the used of which must be carefully optimized, for example using time frames that are relevant to material pharmacokinetics, using the cell lines to which the material will most likely be exposed, and using analytical techniques only where it is known that the analyte does not interfere with the assay. All nanomedicines must display an acceptable risk benefit with respect to proposed use, and early safety studies should be used as a stop – go checkpoint to decide whether or not the technology has promise for further development toward clinical trials in the context of the proposed usage [43].

The nascent field of nanomedicine has evoked enormous interest among physical and biological scientists and has already attracted hundreds of millions of dollars of research funding. The great appeal of nanomedicine lies in its promise of using the unique properties of nanoscale materials to address some of the most challenging problems of medical diagnosis and therapy. While some questions have been raised about the possible toxicity of nanomaterials, and about the ethical implications of applying these advanced technology, the most part nanomedicine has enjoyed enthusiasm [44]. Recent technological advances in nanomedicine and nanotechnology in parallel with knowledge accumulated from the clinical translation of disease and drug related genomic data have created fertile ground for personalized medicine to emerge as the new direction in diagnosis and drug therapy [45]. Although the expectations from nanotechnlogy in medicine are high and the potential benefits are endlessly enlisted, the safety of nanomedicine is not yet fully defined. Use of nanotechnology in medical therapeutics needs adequate evaluation of its risk and safety factors. However, it is possible that nanomedicine in future would play a crucial role in treatment of human diseases and also in enhancement of normal human physiology. With concurrent application of nanotechnology in other fields, its utility is likely to extend further into diagnostics, molecular research techniques and tools [46].

Conclusion

The nanotechnologies developed as nanomedicine today marks a revolution technological in the medical area. These technologies are capable of new diagnostic methods, treatment of current unmanageable diseases, tissue and organs repair, implants, nanodevices, therapies, drug delivery, etc. The first stages of nanomedicine were characterized by an exploratory strategy were new techniques, material offering a great opportunity and benefits for the industry, people, and society. While nanomedicine is starting to appear in almost every domain of our life a concern about safety and possible effects on human health and environment have started to grow. The need for new regenerative strategies has coincided with, and likely promoted, the emergence of the field of nanotechnology. Over the past decade, the focus of nanoscience has shifted from the synthesis, development, and characterization of novel nanostructures, to the exploration of potential applications for this technology to assist in crucial problems as diverse as energy and medicine [47].

Perceptions and misperceptions of risk by policymakers, scientists and members of the public alike play a significant role in decisions to allow technologies to go forward or not, and how best to mitigate any potential problems. Value judgments occur at every step of the process, from the way a technology is represented in various arenas to the determination of what criteria to use to measure effects, to determining who gets to decide which risk are acceptable, and how they are to be evaluated [48].

Nanoparticles are used in nanomedicine as drug carries, and imaging agents, providing selectivity and specificity for disease. The nanoparticles were developed to increase the efficacy of known drugs displaying dose limiting toxicity and poor bioavailability, and to enhance disease detection. Nanotechnologies have gained much interest owing to their huge potential for applications in industry and medicine. It is necessary to ensure and control the biocompatibility of the components of therapeutic nanoparticles to guarantee that intrinsic toxicity does not overtake the benefits. As well as monitoring their toxicity in vitro, and in vivo, it is also necessary to understand their distribution in the human body, their biodegradation and excretion routes, and dispersion in the environment [49].

Nanotechnology may lead to the production of new medical materials, equipments, devices, diagnostic methods and systems with unique properties that cannot be obtained by current process. It is predicted that new developments in nanomedicine will play an important role in advancing knowledge about life quality by promoting human healthy, but this development and all research must include a risk analysis about human health and environmental potential effects.

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