International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 8, Issue 5
May, 2021
Pages: 589-597

A Review of Some Applications of Nanoparticle Technology and New Materials in Medical and Dental Sciences

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http://dx.doi.org/10.18415/ijmmu.v8i5.2571

Abstract

When it comes to nanotechnology it is considered the advanced technologies in the field of working with nanoscale. New materials technology refers to those are molecularly and atomically applied to new materials in the medical sciences. This technology has been able to make dramatic changes in various sciences as a superior technology. Meanwhile, medical sciences are no exception to these developments and this technology has been able to create a revolution in the field of medicine. Today, nano has revolutionized the discussion of drug delivery, the treatment of water-insoluble drugs, the possibility of injecting or injecting drugs, eliminating the side effects of drugs, early detection of diseases, and treatment of terminally ill patients such as AIDS, hepatitis, and cancer. In this article, some applied fields of nanotechnology and new materials in medical sciences are described. Therefore, as nanotechnology is of high significant in the trends of medical sciences, this study as a review is conducted. Library and Internet resources as well as reports of the Presidential Special Nanotechnology Headquarters have been used to collect materials.

Keywords: *Nanotechnology; Drug Delivery; Implants; Imaging*

1. Introduction

Human health is one of the most important categories in medical sciences. Maintaining health and improving the quality of health is always one of the most important issues in the field of public health [1]. Nanotechnology is one of the most modern technologies in the world that has unique features and applications in all fields of science and technology. The nanometer is a very, very small unit for measuring length [2] that is used in atomic and molecular dimensions. To understand the smallness of this unit, it is good to know that each human hair is about 80,000 nanometers in diameter. In general, nanotechnology is the science of arranging atoms to form new molecular structures and create new materials, and since almost all the achievements of human progress have been crystallized in the material around it, nanotechnology can be used in all fields [3]. Nanotechnology does not mean that only we can

make products at the nanoscale, but nanotechnology is essentially the ability to work at the molecular level atom-to-atom to create large, completely new structures with molecular systems. The behavior of single molecules of one nanometer or bulk material is very different from the structural behaviors in the range of single molecules of one nanometer [4]. Nanotechnology refers to materials and systems whose structure and components show new and better physical, chemical and biological properties due to their nanometer dimensions. The purpose of developing nanotechnology is to exploit these aspects through atomic, molecular, extramolecular control, and to learn how to efficiently fabricate and use these devices, maintain the stability and integration of nanostructures, and produce devices on a much larger scale [5]. Meanwhile, the use of new materials are also used in various medical sciences, which can increase their quality and efficiency by using nanoparticles. Among them, we can mention the use of new materials in dentistry [6], cosmetic surgery [7], skin diseases [8], orthopedics [9], etc. In general, nanotechnology studies can be divided into three branches:

1. *Wet nanotechnology:* This branch studies living systems that exist primarily in aquatic environments. In this branch, the genetic generator structure, membranes and other cellular compounds are studied at the nanometer scale [10].

2- *Dry nanotechnology:* This branch is derived from the basic sciences of chemistry and physics and studies the formation of silicon carbon structures and inorganic and metallic materials. In dry nanotechnology, the application of nanometer materials in electronics, magnets and optical instruments is studied [10].

3- *Computational nanotechnology:* In many cases, the available laboratory tools are not suitable for performing some experiments at the nanoscale or these experiments are expensive. In this case, computers are used to simulate the processes and reactions of atoms and molecules. In fact, computing provides the breakthrough in dry and wet nanotechnology [11].

Due to the importance of nanotechnology and the need to pay attention to it in the trends of medical sciences, this study is a review study. Library and Internet resources as well as reports of the Presidential Special Nanotechnology Headquarters have been used to collect materials.

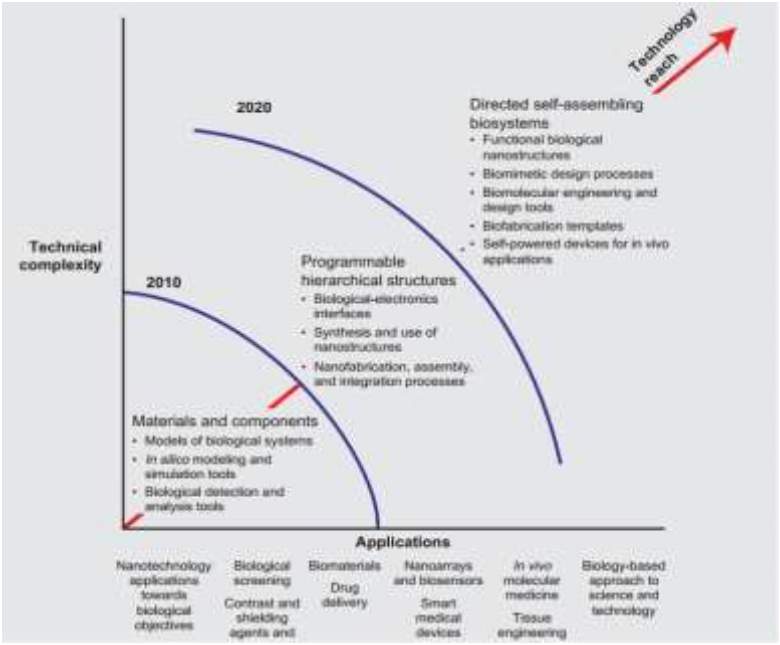

Figure 1 A continuum of opportunity for nanotechnology in the life sciences [10]

2. Properties of Nanomaterials

Properties of nanostructured materials are consisted as below;

1. They can be used for special purposes and possibly multi-purpose use [12].
2. They can feel the changes around them and respond to them [13].
3. They may be 10 times stronger than steel and 10 times lighter than paper [14].
4. They can have paramagnetic or superconducting properties [15].
5. They have higher permeability and melting point [16].

Nanostructured materials have a very small structure compared to many current materials. When the dimensions are smaller than a threshold, a significant qualitative effect occurs. A typical structure, as we know it, is made up of billions of molecules, while nanotechnology deals with groups of several or even one molecule. This difference leads to fundamental changes in the behavior of nanostructured materials and allows for completely new and fundamentally different applications [17-20]. The nanostructured materials of the outer surface are much larger per unit length of volume, and because many important chemical and physical operations take place through the outer surface, a nanostructured material can have different properties than a larger material of the same composition. On the other hand, we can also refer to nanobacteria that are used in various medical[21], dental and other sciences [22-25]. Tools needed in nanomedicine Behavioral tools in nanotechnology are microscopic technologies and equipment necessary for observing and evaluating different items in nanoscale such as cells, bacteria and viruses, as well as identifying single molecules for better understanding of science. AFM microscopes Some of these devices are microscopes of molecular design software and other STM technologies [26].

3. Applications of Nanomedical Technology

The classification of nanotechnology applications in medicine is summarized below. In the following, special research of universities has been considered as examples of research.

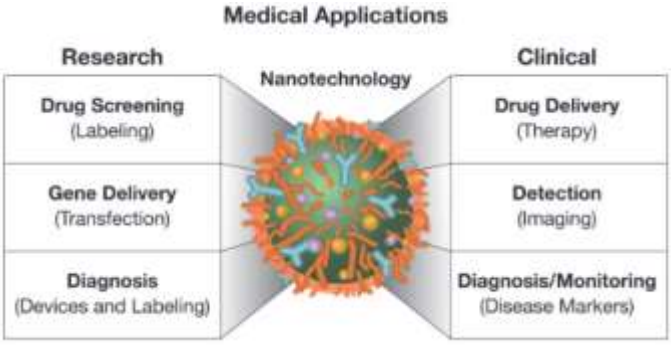

Figure 2 *Medical applications of nanotechnology. The size and tailorability of nanoparticles may lead to their wide-spread use in a variety of medical applications.*

3-1- Drug Delivery

Nanotechnology has provided many opportunities for the development and improvement of the delivery quality of pharmaceutical products. In order for the drug to remain therapeutically effective, it is

necessary to protect the site and protect its biological and chemical properties. Some other drugs are very toxic and cause very bad side effects, and if they are broken down during transmission within the body, their therapeutic effects will be reduced [28]. Drug delivery systems are severely restricted in their use of materials and production processes. The materials in these systems must be biocompatible with the body and easily bind to the drug and can be removed from the body (whether metabolized or excreted). Different ways are excreted from the body) and the production process should be strictly controlled so that the product does not fall apart and they are also suitable in terms of price. Nanotechnology can offer new solutions in the field of pharmaceuticals [29].

A. Encapsulation of drugs:

One of the most important drug delivery systems are substances that protect drugs by covering them as they pass through the body. These materials are hyposomes and polymers such as polyectide (PLA) and lactide-co-glycolide (PLGA) which are used in micron sizes. These materials form coatings around the drug and the release is regulated by the drug. The passage of these substances occurs when they are distributed to body tissues. When the coating materials, instead of micron particles, are the result of nanoparticles in the size of 100-100 nm, they will have a higher contact surface in the fixed volume, so this makes the distribution and opening properties of the coating better [30-31].

B. Active Drug Carriers:

Another type of drug delivery system in which nanotechnology has provided new solutions is that nanoparticles are designed to be active substances that can be transported and identified. These nanostructures can attach to a drug, a target molecule, or an imaging material and then absorb certain cells, releasing what they carry whenever necessary due to the size of the nanoparticles. They have the ability to enter cells because particles smaller than 100 nanometers are normally ingested by cells. Some of the nanostructures used in this feature. Fullerenes are dendrimers and carbon nanotubes [32].

3-2- Implant Materials in the Body

A. Tissue repair and tissue replacement:

Nanotechnology Today has provided a new generation of nanomaterials that have this capability to be used in tissue replacement and repair. Body tissues that have been diseased or damaged may be in urgent need of replacement or repair. While most tissues repair the effects of chemicals and cells, there are differences in the way this tissue is repaired. Hard tissues such as bones and teeth are repaired by producing tissues that are indistinguishable from the original type. They find that in cases where a bone or denture needs to be placed, the materials used may stimulate the immune system, be gradually lost in body fluids, or not attach to diseased bones [33-34]. These problems can lead to new surgeries or the elimination of prosthetic activity. In many cases, these problems occur on the surface between the tissue and the prosthesis, which is due to the characteristics of the type of prosthesis, which gradually reduces its connection to the tissue. To solve this problem, prostheses are usually made of a material with tissue The body's biocompatibility is being coated. This increases the adhesion strength and increases the surface-to-volume ratio and creates a greater contact surface between natural and artificial tissues. Nanotechnology can be effective in repairing and replacing tissue in these cases [35].

Additionally, new materials have been used in Cochlear implant technology, as this small biotechnical part plays very important role in individuals' behavior. Many research has been conducted in this field as implements a variety of sound processing algorithms to improve speech intelligibility [36-37].

B. Implantable coatings

Nanotechnology has provided a number of nanomaterials and coatings with very high surface area and biocompatibility with the body to increase the adhesion and durability of the product. Implantable or their nanoparticles have been used instead of microparticles of the same material [38]. Utilization of such materials regarding high performance and durability leads to high durability which protects materials from fracture and damage [39].

C. Bone repair

Nanotechnology has provided a number of new spaces with biocompatibility with nanomaterials that can be used for bone repair and filling bone cavities. High-strength nanoceramics such as calcium apatite phosphate (CPA) and hydroxyapatite (HAP) can be converted into a flowable, malleable paste that becomes strong bones [9-40].

D. Absorbable materials in the body

Absorbable polymers are now used in decomposed medical products such as sutures and bone fixation devices. Temporary implants can be used. Research is underway on a series of flexible membrane nanofibers for use in open heart surgery in cardiac tissue. These nanomaterials are lost over time and do not adhere to surgical materials and equipment [41].

3-3- Applications in Surgery

Nano- and micro-sized medical devices enable surgeons to perform tasks with better accuracy and safety, and to control physiological and biomechanical parameters with greater direction. Surgery in this case can be based on the needs of the patient. And a surgeon. Surgeon robots: Today, the use of robots built on the basis of nanotechnology instead of using bulky surgical instruments and human hands are being studied. These robots will have arms that act as a surgeon on one arm of a very small camera and the other arms will act as a surgeon. And it does its job [42].

3-4- Diagnostic Tools

A. Genetic tests:

Nanotechnology has provided new solutions to increase the speed and accuracy of the identification of genes and genetic materials for the discovery and improvement of drugs and the preparation of diagnostic products [43]. Highly sensitive methods of adhesion and diagnostic technologies: Several new technologies are being developed in the company to increase the ability to label and identify unspecified genes. Genicon Probes made from particles contain chemicals that can bind to genetic material. These probes begin to radiate when exposed to light. Quantumdot uses quantum dots to identify biomaterials [44]. This technology also makes it possible to use smaller, cheaper devices for identification, and better results can be obtained in less time without the need for gene amplification.

B. Nanotechnology Imaging:

PET is a molecular imaging technique that produces a 3-dimensional (3D) radiotracer distribution map representing properties of biologic tissues, such as metabolic activity or receptor availability. PET images suffer from a relatively high noise level dictated by the Poisson nature of annihilation photon emission and detection. Apart from the technical aspects, PET image quality depends on the amount of

injected radiotracer or acquisition time, which are proportional to the statistics of the detected events [45-49].

New imaging technologies are proposed in which high-quality images that cannot be produced today are produced, and this will be accompanied by new therapies [50].

1. *Nanoparticle Probes:*

University of Michigan experts are developing nanoprobes that can be used in magnetic resonance imaging (MRI). In this nanotechnology, nanoparticles that have a magnetic core attach to antibodies that bind to cancer cells when these nanoprobes are attached to cancer cells and are well detected on MRI. At this time, cancer cells can be killed with a laser [51].

2. *Reduced shooting devices:*

It will be possible to make small wireless devices for shooting with much higher quality than before with nanotechnologies. Giren has developed a tablet with a small video camera. When swallowed, the pill moves along the gastrointestinal tract and takes pictures every few seconds. Therefore, the entire length of the gastrointestinal tract can be examined for bleeding tumors and diseases that cannot be accessed by colonoscopy and endoscopy [52].

3-5- Treatment of Cancers

Early detection of cancer is very important in improving its treatment methods. At present, the diagnosis and diagnosis of cancer is usually based on changes in cells and tissues, which can be done with a doctor's clinical examination or conventional imaging techniques [53-54]. Scientists are trying to diagnose cancer with the first molecular changes. Nanotechnology is very suitable for detecting molecular changes. Nanotechnology tools will allow doctors to perform their experiments without changing tissues or cells. Reducing the size of screening tools makes tests faster and cheaper. One of these tools is the cantilever, which will be effective in diagnosing cancer [55-57]. These tools are small rods that are engineered by the techniques of their constructs. They bind to cancer-related molecules. They can even attach to altered DNA sequences or proteins that cause some cancers [58-59]. By connecting these molecules to the cantilevers, the change in surface tension causes them to bend. By controlling whether the cantilevers are bent or not, it is possible to predict cancer. This method will be useful in the rapid detection of molecular events during the onset of cancer [60] One of the challenges in cancer diagnosis is the detection of circulating cancer cells. In this regard, magnetic nanoparticles are used for screening, diagnosis and determination of the severity and detection of circulating cancer cells [61].

Conclusion

Today, nanotechnology has been able to create a new approach in various fields of medicine. Perhaps it can be said that the most important effect of nanotechnology on medical sciences is to increase the efficiency of various methods and create new methods and reduce economic costs in this field. This has caused different countries to step forward in this area as fast as they can. In the present descriptive article, which focuses on the importance, classification and effects of nanotechnology in medical sciences, in fact, a small part of the capabilities and potentials and profound effects of this technology on the medical field is discussed. Hope that in our country the efforts in this direction will be doubled.

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