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# Nanomedicine: The Newer Generation Fusion Molecular Nanotechnology

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**ABSTRACT**

In this article we reviewed the current trends in nanotechnology which are helpful to field of medical sciences that could imagine a world where medical nanodevices are routinely implanted or even injected into the bloodstream to monitor health and to automatically participate in the repair of systems that deviate from the normal pattern. The continued advancement in the field of medical nanotechnology is the establishment and collaboration of research groups in complementary fields. Our core interest is to attract the researchers in the field of nanotechnology medicines that we should be used in the near future.

**Key words*:*** Medical nanodevices, Blood stream, Nonotechnology

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## INTRODUCTION

Nanomedicine, an emerging new field, is an outcome of fusion of nanotechnology and medicine. Nanomedicine is the medical application of nanotechnology. It covers areas such as nanoparticle drug delivery and possible future applications of molecular nanotechnology (MNT) and nanovaccinology. [1, 2]

### *Nanomedicine*

Nanomedicine is the process of diagnosing, treating, preventing disease and traumatic injury, of relieving pain, and of preserving and enhancing human health, using molecular tools and molecular knowledge of the human body. [3-6].

### *Molecular Nanotechnology*

Molecular nanotechnology (MNT) is the concept of engineering functional mechanical systems at the molecular scale. An equivalent definition would be "machines at the molecular scale designed and built atom-by-atom". Examples of nanomedicine in modern use are the manufacture of colloidal nanoparticles in bulk form, such as suntan lotion, cosmetics, protective coatings, stain resistant clothing, nanodeodourant, powder, spray etc [7-12].

### *Medical Nanomaterials*

The initial medical applications of nanotechnology, using nanostructured materials, are already being tested in a wide variety of potential diagnostic and therapeutic areas. [13-15].

### *Fluorescent Nanoparticles*

Fluorescent nanoparticles help to pinpoint the location of cancer cells, find out how viruses invade the cell and proteins operate in the body. [16] This can lead to better treatments and minimize the damage of healthy tissues. Nanotubes are used to create synthetic tissues. [17] Researchers have found that carbon nanotubes can withstand repeated stress and yet retain their structure and mechanical integrity similar to the behaviors of soft tissues.

Another early goal of nanomedicine is to study how biological molecular receptors work, and then to build artificial binding sites on a made-to-order basis to achieve specific medical results. Scientists have researched the engineering of polymer surfaces containing arrays of artificial receptors. In a recent series of experiments researchers used a new radiofrequency-plasma glow-discharge process to imprint a polysaccharide-like film with nanometer-sized pits in the shape of such biologically useful protein molecules as albumin (the most common blood protein), fibrinogen (a clotting protein), lysozyme and ribonuclease (two important enzymes), and immunoglobulin (antibodies). [18, 19] Each protein type sticks only to a pit with the shape of that protein. These surfaces may be used for quick biochemical separations and assays, and in biosensors and chemosensors, [20] because such surfaces will selectively adsorb from solution only the specific protein whose complementary shape has been imprinted, and only at the specific place on the surface where the shape is imprinted.

***Dendrimers***

Dendrimers are tree-shaped synthetic molecules with a regular branching structure emanating outward from a core.Use of dendrimers is safe and a more effective genetic therapy agent. These nanostructures are attractive because they can sneak DNA into cells while avoiding triggering an immune response, unlike viral vectors commonly employed today for transfection. The dendrimer molecule is decorated with specific snippets of DNA, and then injected into biological tissue. Upon encountering a living cell, dendrimers of a certain size trigger a process called endocytosis in which the cell's outermost membrane deforms into a tiny bubble, or vesicle. The vesicle encloses the dendrimer, which is then admitted into the cell's interior. Once inside, the DNA is released and migrates to the nucleus where it becomes part of the cell's genome. The technique has been tested on a variety of mammalian cell types. [21].

***Smart Drugs***

Medical nanomaterials also may include "smart drugs" that become medically active only in specific circumstances. A good example is provided by Yoshihisa Suzuki at Kyoto University, who has designed a novel drug molecule that releases antibiotic only in the presence of an infection. Suzuki started with the common antibiotic molecule gentamicin and bound it to a hydrogel using a newly developed peptide linker. Immunotoxins are another class of smart drugs, in this case activating only in the presence of cancer cells. An immunotoxin molecule is an engineered hybrid of functional protein modules fabricated from two different types of proteins: a toxin and an antibody. Toxin proteins are normally produced and released by infectious bacteria. The toxin protein binds to the surface of a host cell, penetrates it, and kills it. Toxin molecules are so potent that just a few of them can kill a cell. Antibodies are proteins produced by the immune system to recognize and bind to specific foreign materials. An immunotoxin molecule is made by fusing a part of the gene encoding a toxin with a part of the gene encoding an antibody that recognizes surface features on cancer cells. This creates a novel gene that can be used to express a new synthetic protein molecule. This new molecule will bind only to a cancer cell (via a module from the antibody protein), then penetrate it and kill it (via modules from the toxin protein). The first experiments with mice showed that these engineered proteins successfully eliminated certain tumors. [22-26].

***Nanopore Immunoisolation Devices***

Scientists employed bulk micromachining to fabricate tiny cell-containing chambers within single crystalline silicon wafers. The chambers interface with the surrounding biological environment through polycrystalline silicon filter membranes, which are micromachined to present a high density of uniform nanopores as small as 20 nanometers in diameter. These pores are large enough to allow small molecules such as oxygen, glucose, and insulin to pass, but are small enough to impede the passage of much larger immune system molecules such as immunoglobulins and graft-borne virus particles. [27, 28].

### *Nanopore Sensors*

The flow of materials through nanopores can also be externally regulated. The first artificial voltage-gated molecular nanosieve was fabricated by Charles R. Martin and colleagues at Colorado State University in 1995. Martin's membrane contains an array of cylindrical gold nanotubules with inside diameters as small as 1.6 nanometers. When the tubules are positively charged, positive ions are excluded and only negative ions are transported through the membrane. When the membrane receives a negative voltage, only positive ions can pass. Future similar nanodevices may combine voltage gating with pore size, shape, and charge constraints to achieve precise control of ion transport with significant molecular specificity [28].

### *DNA-Based Nanodevices*

The idea of using DNA to build nanoscale objects has been pioneered by Nadrian Seeman at New York University .Two decades ago; Seeman recognized that a strand of DNA has many advantages as a construction material. First, it is a relatively stiff polymer. Its intermolecular interaction with other strands can be readily predicted and programmed due to the base-pair complementarity of nucleotides, the fundamental building blocks of genetic material. DNA also tends to self-assemble.

Exploratory areas for nanomedicine will include Research into the condition and/or repair of the brain, finding application in designing pharmaceuticals as a function of patient genotypes .The synthesis of more effective and biodegradable chemicals for agriculture.Employing this technology it should also be possible to develop methods that use saliva instead of blood for the detection of illnesses, to perform complete blood testing within a short period of time. DNA repair machines can repair or replace damaged or miscoded sections of chromosomes. Other medical nanorobots capable of cell repair can purge human tissue cells of unhealthy accumulated detritus and restore these cells to their youthful vigor. [29-31].

### *Drug Delivery*

Drug delivery systems, lipid- or polymer-based nanoparticles, can be designed to improve the pharmacological and therapeutic properties of drugs. The strength of drug delivery systems is their ability to alter the pharmacokinetics and biodistribution of the drug. Nanoparticles have unusual properties that can be used to improve drug delivery. Where larger particles would have been cleared from the body, cells take up these nanoparticles because of their size. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell walls and into cells. Efficiency is important because many diseases depend upon processes within the cell and can only be impeded by drugs that make their way into the cell. Triggered response is one way for drug molecules to be used more efficiently. Drugs are placed in the body and only activate on encountering a particular signal. Potential nanodrugs will work by very specific and well-understood mechanisms, one of the major impacts of nanotechnology and nanoscience will be in leading development of completely new drugs with more useful behavior and less side effects. [32-34].

### *Nanodevices*

Nanodevices in medical sciences could function to replace defective or improperly functioning cells, such as the respirocyte proposed by Freitas. [35] This man-made red blood cell is theoretically capable of providing oxygen more effectively than an erythrocyte. It could replace defective natural red cells in blood circulation. Primary applications of respirocytes may involve transfusable blood substitution, partial treatment of anaemia, prenatal/neonatal problems, and lung disorders.It has been reported that nanomachines could administer drugs within a patient’s body. Such nanoconstructions could deliver drugs to peculiar sites making treatment more accurate and precise. Similar machines with specific ‘weapons’ could be used to remove obstacles in the circulatory system or in the identification and killing of tumour cells. [36] The other vital application of nanotechnology in relation to medical research and diagnostics are nanorobots. Nanorobots, operating in the human body, could monitor levels of different compounds and record the information in the internal memory. [37] They could be rapidly used in the examination of a given tissue, surveying its biochemical, biomechanical, and histometrical features in greater detail.

### *Recent Developments*

Medical diagnosis with appropriate and effective delivery of pharmaceuticals is the medical areas where nanosize particles have found practical applications. However, there are many other interesting proposals for the use of nanomechanical tools in the fields of medical research and clinical practice. Such nanotools are awaiting construction, and presently are more like a fantasy. Nevertheless, they might be quite useful, and become a reality in the near future.

### *Risks of Nanomedicine*

Nanotechnology in medicine faces enormous technical hurdles in those long delays and numerous failures are inevitable. Likewise, it should not be taken for granted the dangers and negative consequences of nanobiotechnology when applied in warfare, in the hands of terrorists and disasters associated with its application in energy generation when and wherever it strikes or the risks associated with nanoparticles in blood circulation.

Nanomedicine, in general, is new and little experimental data about unintended and adverse effects exists. The lack of knowledge about how nanoparticles might affect or interfere with the biochemical pathways and processes of the human body is particularly troublesome. Scientists are primarily concerned with toxicity, characterization and exposure pathways.

Other than the obvious potential risks to patients, there are other toxicological risks associated with nanomedicine. Concerns over the disposal of nanowaste and environmental contamination from the manufacture of nanomedical devices and materials are valid.These are potential risks which need to be carefully assessed.

***Summary***

The multidisciplinary field of nanotechnology's application for discovering new molecules and manipulating those available naturally could be dazzling in its potential to improve health care. The spin-offs of nanobiotechnology could be utilised across all the countries of the world.
In the future, we could imagine a world where medical nanodevices are routinely implanted or even injected into the bloodstream to monitor health and to automatically participate in the repair of systems that deviate from the normal pattern. The continued advancement in the field of biomedical nanotechnology is the establishment and collaboration of research groups in complementary fields. Such collaborations have to be maintained not only on specialty field level, but internationally as well. The successful development and implementation of international collaborations fosters a global perspective on research and brings together the benefits to mankind in general. It should be appreciated that nanotechnology is not in itself a single emerging scientific discipline but rather a meeting point of traditional sciences like chemistry, physics, biology and materials science to bring together the required collective knowledge and expertise required for the development of these novel technologies.

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