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Nanotechnology in Medical Field

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Abstract: Nanotechnology is the field of using the technology and science that focuses on using molecular level regulation of matter that are of size range less than 100 nm range. In the field of nanotechnology, there are two primary approaches. The two main approaches are "Top-down" approach and "Bottom-up" approach. With a "Bottom-up" approach, materials and gadgets made of molecules that chemically put themselves together using molecular recognition principles are used. The nano-objects are created from larger entities using "Top-down" approach without atomic-level control. In fact, nanotechnology has been useful in a variety of medical fields, including cardiovascular medicine, oncology and the treatment of other chronic illnesses, as there is a significant need for the creation of pharmaceuticals and because the biological elements of live cells play crucial functions at the nanoscale. Undoubtedly, nanotechnology is being utilised to improve the identification of biomarkers, medication development, drug delivery and molecular diagnostics, all of which may be useful in the treatment of these patients. The importance of nanotechnology in the medical sciences and the reasonable side effects of its use will be highlighted in this paper.
Keywords: Nanotechnology, medicine, toxicity, nano devices, diagnostics

I. INTRODUCTION

"Nano" means very small, it comes from a Greek word "nano", which means dwarf. Nanotechnology is a branch of applied science and technology that focuses on manipulating molecules at the molecular level that are smaller than 100 nm. Nanotechnology opens some new ways to prevent and fight against illnesses by customization of materials at atomic level. Unveiling the structures and functions of biosystems at the nano-level is its main ability which vitalizes research that leads to improvement in biotechnology, medicine and healthcare. Nanotechnology produces significant technological and scientific advancements in various fields like medicine and physiology. Another way to think of nanotechnology is as an expansion of current science onto the nanoscale or as an updated version of current science using a newer, more sophisticated term. It is anticipated that the nanotechnology would significantly improve both human health and medical field.

II. NANOTECHNOLOGY IN MEDICAL FIELD

A. Applications of Nanotechnology

Nanotechnology has been used in a variety of medical disciplines, including oncology and cardiovascular medicine, due to the ongoing need for the creation of new medications and the crucial nanoscale roles played by the biological elements of living cells. Unquestionably, the use of nanotechnology is advancing the identification of biomarkers, medication development, drug delivery and molecular diagnostics, which could possibly be helpful in the treatment of these patients. By precisely creating new molecular assemblies and modifying atoms on the size of organelles, individual cells, and even smaller components, nanotechnology aims to create and combine new materials and provides individualized medicines. Due to the rising usage of nanotechnology, it is important to carefully consider the danger of nanoparticle exposure, the molecular processes of potential cytotoxicity and the routes of entry. The physiochemical characteristics of living things can be changed at the nanoscale by these tiny particles, which enters the body via the skin, intestinal organs or lungs, and lodge in quite a few organs. This can result in harmful biological reactions. Additionally, whether nanoparticles are vigilant or removed from the various organs of entry and whether the host can mount a successful defence to appropriate or eliminate the particles will all affect how detrimental they are. Researchers discovered that nanoparticles are to blame for the toxicity in various systems.

B. Nanomedicine

"Nanomedicine" is the technology and scientific field that uses nanoscale structured materials, genetic engineering, biotechnology, various complex machine systems, and nanorobots to diagnose, prevent, treat, and alleviate the pain of diseases and devastating injuries in addition to helping maintain and improve human health. It was evaluated as including five sub-disciplines that frequently overlap when it comes to technical concerns.

C. Nano Diagnostics

Nanodevices are employed for the molecular and cellular level early detection of disease or propensity. Nanomedicine has the potential to improve the accuracy and efficiency of in-vitro diagnostics using samples of human fluids or tissues, perform multiple studies at the cellular level, and more. By using nanotechnology in the medical industry, in-vivo diagnostics devices that can operate within a human body to determine a disease's existence at the earliest possible time, to identify and estimate hazardous chemicals and tumour cells, might be developed.

D. Applications in Medicine

It should be possible to build machines on the micrometre scale using nanometre-sized components in 10–20 years. These devices might feature practical robotic elements like 10 nm sorting rotors for molecule-by-molecule reagent purification, 100 nm manipulator arms, and super-smooth, atomically perfect diamond surfaces. Such nanomechanical device control, activation, and deactivation would fall under the purview of nano computers. To ensure that the operation of the nanomechanical devices is secure, nano computers would keep contextual information, store and execute mission plans, receive and process external signals and stimuli, communicate with other nano computers or other external monitoring and controlling devices. The medicinal ramifications of this technology are vast. The crucial responsibility of activating, deactivating, and managing such nanomechanical devices would fall to nano computers. Nano computers would be able to communicate with other nano computers or other external monitoring and controlling devices, receive and process external signals and stimuli, execute and store mission plans, and have contextual information to confirm the safe operation of the nanomechanical components. The technology has important effects on medicine and dentistry. Medical professionals can perform precise treatments at the molecular or cellular level with the aid of programmable nanorobotic devices. In addition to mechanically reversing metabolic derangement, enabling near-instantaneous homeostatic mechanisms, enhancing the immunity system, improving respiratory capacity, repairing brain damage, Medical nanorobots have been developed for genotological applications in pharmaceutical research, clinical diagnosis, and dentistry, rewriting or replacing DNA sequences in cells, and fixing gross cellular abuses whether caused by viscous dissipation or by cryogenic storing of biological tissue. Albert R. Hibbs presents a very fascinating potential for fairly small machines. According to Feynman, who made the first known suggestion for a nanorobotic surgical method to treat heart problems. Although it is a really crazy idea, he claims that swallowing the surgeon would be intriguing in surgery. The mechanical surgeon enters the blood vessels and travels to the heart, where it scans the area. Such small machines might be permanently implanted in the body to assist specific organs that are not operating properly. It determines which valve is the defective one and take a knife and chops it out. Many bacteria and viruses that cause disease are nanosized. So, it stands to reason that nanotechnology would give us tools to defend ourselves. When antibiotics entered the scene, the ancient Greeks' use of silver to prevent infection and promote healing was put on hold. By using nano-sized silver particles, which are more sensitive than bulk form of the metals, to cover a burn and wound bandage, Nycryst Pharmaceuticals (Canada) has revived and improved a long-used remedy. They gradually work their way in by puncturing the skin. As an outcome, the burn sufferers can change their dressing once each week. The molecular causes of many diseases are already becoming increasingly clear thanks to genomics and proteomics research. This has opened up new possibilities for developing effective diagnostic tools that can identify genetic illness predisposition. Fact of care diagnosis will often be utilised in the future to identify patients who need preventative medication, choose the best drug for each patient, and track treatment response. A vital role for nanotechnology in developing affordable diagnostic tools [Fig 1].

Fig. 1 Image of Nanorobots

E. Use of Nanotechnology to Pharmacology, Therapeutics, and Diagnosis

Biomarker-based genomics and proteomics tools are being made useful by nanotechnology. By protecting a biomarker from deterioration and strengthening it to enable more delicate analysis, for quantitative or qualitative in-vivo or ex-vivo diagnosis, nanoparticles can be utilised.. The signals of tiny, rich biomolecules can be amplified in early experiments using single "bar code" DNA fragments and magnetic nano particle probes coated with antibodies. This enlarging is similar to the enlarging of nucleotide sequences by polymerase chain reaction (PCR), and it can potentially be used to think of hundreds of protein targets int patient diagrams at once. Such research would improve patient outcomes by enabling doctors to accurately diagnose disease at an early stage and initiate therapy before serious cellular damage occurs. For instance, flow cytometry has been used to identify the epidermal growth factor receptor in human epidermoid carcinoma cells using in-vitro streptavidin-coated fluorescent polystyrene nanoparticles. Additionally, the prostate specific antigen (PSA), a cancer marker, has been detected at low concentrations in blood using nanoparticle oligonucleotide bio barcode assay. By employing this novel method, test sensitivity can be greatly increased due to the high ratio of PCR amplifiable DNA to tagging antibody that is proposed. Therefore, individuals with prostate cancer or even women could have low levels of free serum PSA. 82 Asian Journal of Pharmaceutics - April 2008 Suffering from breast cancer with a significant increase in tumour screening and analysis Gaur, et al.

F. Toxicity of Nanoparticles

Despite the fact that humans have always been highly susceptible to nanoparticles, due to the industrial revolution, this exposure has increased significantly over the past century. A portion of particulate matter is made up of nanoparticles (PM). According to epidemiological research, airborne particulate matter from combustion sources, such as motor vehicles and industrial pollutants, leads to cardiovascular and respiratory illness and mortality in urban areas. A classic ambient particulate is a very complicated combination of particles with diameters between one nanometre and one hundred millimetres. These particles include a significant amount of carbon in its elemental form, and the size of these particles affects how well they can affect the systemic circulatory system. In actuality, the vasculature can be easily accessed by ultrafine and fine PM(mass median aerodynamic diameter: 0.1 to 2.5 mm), which has been linked to cardiovascular dysfunctions, especially in relation to pre-existing vascular disorders. Human exposure to purposefully created artificial nanoparticles will definitely increase with the expanding usage of nanotechnology in high-tech companies. Moreover, medical sciences are experimenting with nanotechnology in an effort to provide individualised medicine. In fact, the same characteristics that make nanoparticles so appealing in medicine— small scale, chemical makeup, structure, huge surface area and shape—might also apply to their poisonous form in biological systems. Nanoparticles are extremely reactive in the cellular environment due to their smaller size and greater surface area per mass unit. Any inherent toxicity of the particle surface will therefore be increased. Nanoparticles have been observed to target the skin, blood, respiratory system, gastrointestinal tract, and central nervous system.

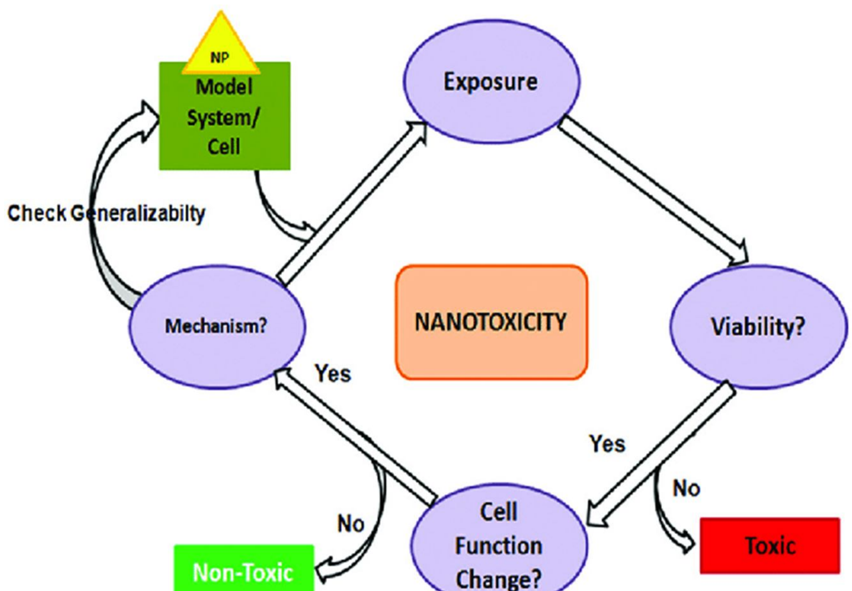

Fig. 2 Image of Nanotoxicity

III. CONCLUSION

It is anticipated that clever nanomedical devices based on nanoparticles and nanomaterials will be used for drug discovery and delivery, molecular tests, and the identification of biomarkers. Nanoparticles may also have toxicological effects, so the development of novel nanoparticles for diagnostics, pharmacology and therapies must continue concurrently with calculations of any toxicological and environmental side effects of these particles. The variety of manufactured nanoparticles and the abundance of possible side effects are two of the main tasks for therapies and nano pharmacology. Modern medical technology has the ability to change the human body in ways that were unthinkable a century ago. Future uses of nanobiotechnology will modify human body (on a nanometre) in ways that we are currently unable to imagine.

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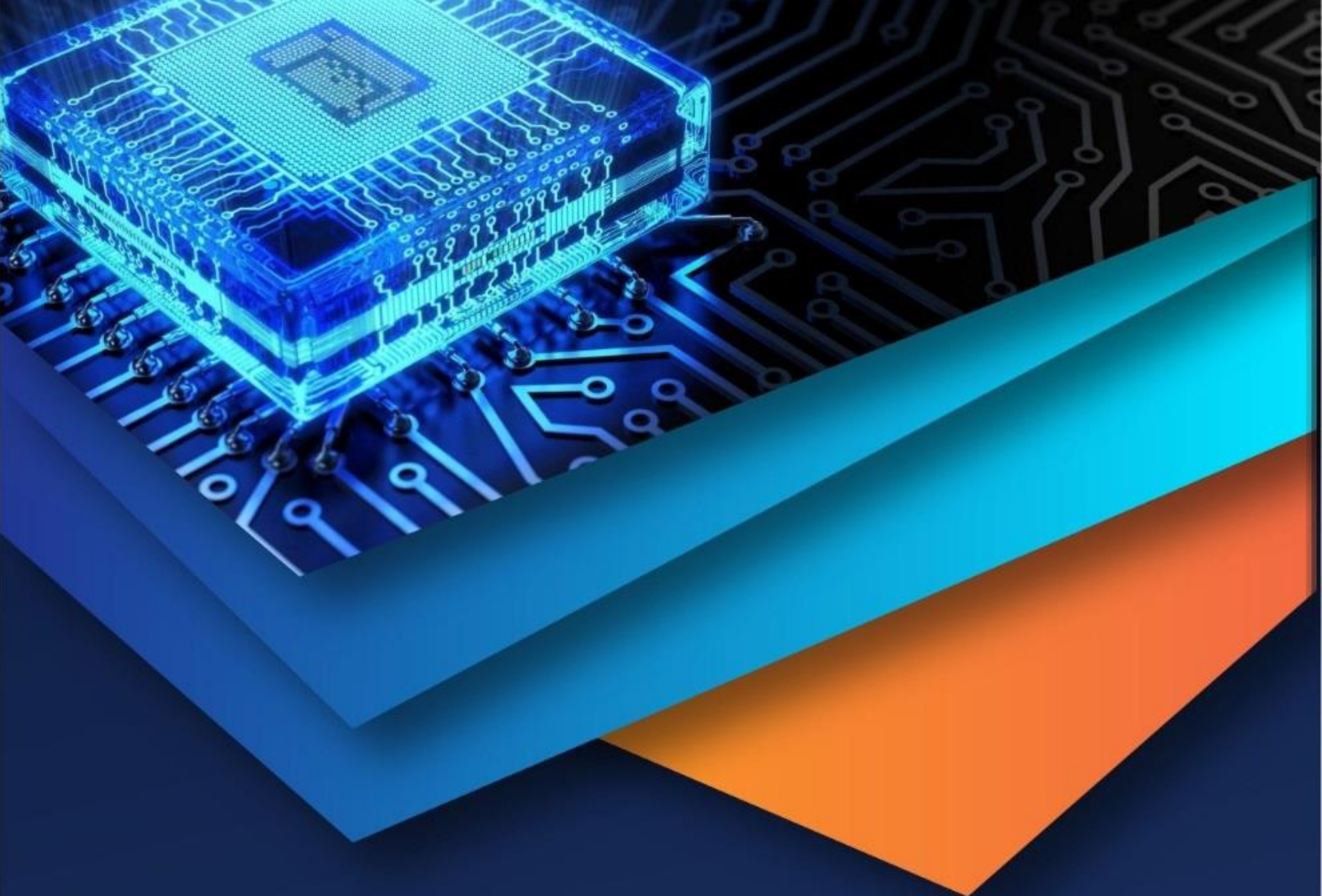

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