NANOBIOTECHNOLOGY

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ABSTRACT

Nanobiotechnology is an emerging science which uses nanotechnology in the biological field. It uses biological materials which are in nanosized range. It has applications in various aspects of life as in the medical, agricultural, industrial, environment and biological sciences. It has enhanced the efficiency of various techniques like drug delivery, water and soil remediation and enzymatic processes. Nanobiotechnology has been widely studied for its potential to advance in the field of biotechnology and medical researches, but its safety is not fully defined yet.

Keywords— *nanobiotechnology,medical science,nanoparticles*

**I.** **INTRODUCTION**

Nanobiotechnology, which is a combination of nanotechnology and biotechnology is defined as the development, design and application of nanomaterials and devices which deals with the functional processes of biological agents.1 It is a multidisciplinary field that covers a diverse areas of technologies from engineering, chemistry, physics and biology.2

Nanobiotechnology has opened up rapid advances in various fields of science and technology, which creates new opportunities for advances in the fields of medicine, electronics, foods, environment, etc. Nanoscale structures and materials (nanoparticles, nanowires, nanofibers, nanotubes) have been explored in many biological applications (biosensing, biological separation, molecular imaging, anticancer therapy) because the functions of their novel properties differ drastically from their bulk counterparts. Their high volume/surface ratio improved solubility and its multifunctionality has open up many new possibilities.

It is a fact that nanobiotechnology embraces and attracts many different disciplines, encompassing both researchers and business leaders, producing many examples of bio inspired de novo designed materials or structures.3 Working at the atomic or molecular level allows researchers to develop innovations that will drastically improve our everyday lives. The new territory of it holds the promise of improving our health, our industry and our society in ways that may even surpass what computers and biotechnology have already achieved. The science of nanobiotechnology is expected to have a rapid and diverse growth and development in the coming future.

**II. BACKGROUND HISTORY**

The history and origin of nanobiotechnology begins by Richard Feymaan's historic 1959 dec 29 lecture at the California Institute of Technology titled “There is plenty of room at the bottom” in which he outlined the idea of building objects from the bottom up by directly manipulating atoms. Today that idea is considered to be the first landmark of science at the nano level. This brilliant suggestion did not gain much importance until the mid 1980s when Eric Drexler published “Engines of creation” in 1986, a popular treatment of the promises and potentials of nanobiotechnology. Drexler envisioned a molecular nanotechnology discipline that would allow manufactures to fabricate materials from the bottom up with precise molecular control.

The National Nanotechnology Initiative defines nanotechnology as research and development at the atomic, molecular or macromolecular levels to create devices, structures and systems in the sub 100 nm range that have novel functional properties. At this scale, scientists can manipulate atoms to create lighter, efficient and more stronger materials with tailored properties. Given the inherent nanoscale functions for the biological components of living cells, it was inevitable that nanotechnology would be applied to the life sciences. Such applications give rise to the term “nanobiotechnology”, a unique merger of biotechnology and nanotechnology.

**III. APPLICATIONS OF NANOBIOTECHNOLOGY**

1. MEDICAL APPLICATIONS

1. DIAGNOSIS: The goal is to design new methods for diagnosing a number of diseases at an earlier stage with cheaper materials and more sophisticated equipments than is possible today. Aaron et al have shown that 25nm gold nanoparticles when conjugated with anti epidermal growth factor receptor monoclonal antibodies can be efficiently used as in vivo targeting agents for imaging cancer markers, specially epidermal growth factor receptors. Also gold nanoparticles are used as sensors for detecting sensitive DNA. The gold nanoparticles result in a dramatic increase in signal contrast compared to other antibody fluorescent dye targeting agents. Also an interesting tool being developed today to be utilized in tumor diagnosis is RNA nanoparticles. Shu and Colleagues have also developed a toolkit to obtain stable RNA nanoparticles.

B)THERAPEUTIC: The advantages of cancer treatment by nanoparticles engineered by nanobiotechnology are faster destruction of the tumor cells with less damage to a normal tissues. By this, the potential of standard chemotherapy and irradiation are increased. Nanoparticles deliver chemotherapeutic drugs in a potent way than standard treatment methods, directly to tumor cells by giving a signal after the destruction of the cells. Applied nanobiotechnology used for regenerating and protecting the central nervous system will effectively provide advantage from nanotechnology research conducted at the basic level in conjunction with advanced neurophysiology, nanopathology and cell biology. Nanomaterials are used to deliver the therapeutic effect, directly to the site, requiring a lower dose. These materials use a specific molecular structure which interacts with protein structures or neurons of the cells. In cardiovascular diseases, nanoprobes target plaque components to detect patients having maximum risk of disorder. Antimicrobial nanoemulsions, consisting of alcohol, water, soybean oil, detergent agents with size range of 200 to 400nm destroy the micro-organisms potentially without toxic effects.4

C). GENE THERAPY: The nanodevices has the advantage of entering the cells more easily than the larger devices and therefore, interact better and effectively with the cells. The use of nanotechnology in gene therapy could be applied to replace the currently used viral vectors with potentially less immunogenic nanosize gene carriers. Delivery, therefore, of repaired genes or the replacement of incorrect genes are fields in which nanoscale objects could be introduced successfully. The use of nanotechnology and nanoparticles, has some advantages in gene delivery: the structure of the nanoparticles is protecting the nucleic acids from degradation by nucleases and the environment; it also minimizes side effects by directing the nucleic acid to the specific location of action; they facilitate cell entry of nucleic acids and normally nanoparticles sustain gene delivery for longer periods when compared to other vehicles. Eg: Delivery of the genetic material into the target cells may be possible by using Liposomes of size below 100 nm. Liposomal formulations developed with the incorporation of polyethylene glycol, galactoses are effective in targeting liver cells because of their fast uptake using Kupffer cells of liver. In this way, gene therapy can be achieved to treat numerous liver disorders.

D). DRUG DELIVERY: A drug delivery system designed using nanobiotechnology tools and devices have minimized the problems like less solubility, less bioavailability, instability of drug in in-vivo conditions, toxic effects and improve the drug effect at the target site. Generally, the drug delivery system using this technique consists of components like drug, a material encapsulating the drug and surface coating materials. Examples of the nanobiotechnology dependent drug delivery systems includes the following- In Cancer therapy the administration of Doxorubicin, using nanocarriers like liposomes penetrates the tumors passively thereby enhancing the efficiency of the active product ingredient therapeutically with minimized adverse effects. Electrospun nanofifibers may serve as a promising delivery vehicle as a result of their 3D nano-sized features that closely resemble those of the ECM. By this technique it is possible to incorporate biological molecules by using an emulsion or directly in a polymer solution.

E). PRODUCTION OF BLOOD SUBSTITUTES: Based on Nanobiotechnology fundamentals, first generation RBC substitutes such as poly Hb, conjugated Hb, can remove infective HIV agents, Hepatitis virus, etc. Poly Hb has been approved and recommended for the use of human in South Africa.

1. TISSUE ENGINEERING

In tissue engineering, the damaged tissue is regain or reconstruct through the use of growth factors, cell therapy, injectable biopolymers and biomaterials which is seen as support for the development of the cells. Cells interact with the surrounding environment on a nanometric scale. Electrospinning is the widely used techniques used for constructing biomaterials to be cultivated with cells.

1. PATHOGEN DETECTION

Food borne pathogens need to be monitored throughout the food chain from production, processing and distribution to the point of sale. Elemental silver and silver salts can be used as antimicrobial agents for curing and preventing various health problems for centuries. The antimicrobial activity of the silver salts and complexes are generally based on the bonding of metallic ions in various biomacromolecular components. Therefore, A nanoparticle with specific optical, electrochemical or magnetic properties increases the detection ability of the diagnostic methods by incorporating them into biosensor systems. Further, the possibility of using them in a variety of configuration allows implementing these nanoparticles as a point of care systems for human health and multiplex devices.

1. FOOD SAFETY

Nanobiotechnology in food involves mainly adding antioxidants, antimicrobials, biosensors, and other nanomaterials at packaging. Among the available metal nanoparticles, silver and related materials have been utilized in many nanobased commercial products for their antimicrobial property. Studies suggest that the antimicrobial performance is enhanced due to an intensive surface area/reduced particle size. For the distribution of food, natural biopolymer-based nanocomposite films used for food packaging for safe storage, nanowire immunosensors array for detection of microbial pathogens, for quick detection of food-borne pathogens using bioconjugated nanomaterials, biosensor, nanocantilevers and carbon nanotubes and nanoscale titanium dioxide particles as a blocking agent of UV light in plastic packaging.

**IV. CURRENT STATUS OF NANOBIOTECHNOLOGY**

Nanobiotechnology is still in the early stages of development. However, its development is multidirectional and very rapid. Investment in nanotechnology is now receiving full support from governments, research centres and various companies. The areas of potential development are synthesis and use of novel nanomaterials and nanostructures, analytic methods and instruments for studying single biomolecules, devices and nanosensors for the early point of care, detection of diseases and pathogens, identification of novel biologic targets for imaging, diagnosis and therapy and nanotechnology for tissue engineering. Three patients from America have received whole cultured bladders using nanobiotechnology principles. By conducting studies on animals it has been demonstrated that it is possible to grow a uterus in in-vitro conditions and then introduced in in-vivo conditions in the body. In the United States, Stem cell treatments to cure cardiac disorders are under clinical trials. Researches are going on in allowing individuals to have new limbs without having to resort to prosthesis. An example of the current nanobiotechnological research is fluorescent polymer coated nanospheres, where fluorescence of polymer is quenched when they encounter with specific molecules. These polymer-coated spheres as part of new biological assays might someday lead to particles which can be introduced into the human body in finding out the metabolites linked with various diseases like tumors, etc. But multiple challenges confront the commercialization of nanomaterials, including large scale production, high production costs, scarcity of venture funds, a well established nanometer scale industry and the absence of clear regulatory guidelines.

**V. CHALLENGES FOR NANOBIOTECHNOLOGY**

A). Humans and animals exposed to the environment potentially contaminated with nano-materials may need to be followed and monitored for any adverse consequences.

B). To detect and determine the toxicity of engineered nanomaterials.

C). Proposing models for predicting the effects of these nano-materials on human health and the environment.

D). To evaluate the impact of engineered nano-materials on the environment and human health over the entire life span.

E). A grand challenge would be to develop the tools to properly assess risk to human health and to the environment. Commercialization challenges of nanobiotechnology include uncertainty of effectiveness of innovation, scalability, funding, scarce resources, patience, etc.5

**VI. NANOTOXICITY**

Since the size of the molecules or atoms are thin and small, a large proportion of the molecules or atoms that make up a nanoparticle are exposed to the exterior of the particle and become free to participate in various biological and chemical processes. Nanoparticles, as a result of their extreme microscopic dimension, which gives unique advantage, have potential hazards similar to particulate matters. These particles have the potential to cause various diseases of different systems of the body. In order to better understand the hazards of materials and develop safer nanomaterials, studies in the nanobiointerface must be made. These studies include analysis of the effect of physiochemical properties of cell bioavailability, uptake and bioprocessing. Studies also need to be made to optimise these particles for their utility in nanomaterials for therapeutic use. Numerous studies on the toxicological effects of nanomaterials are underway. However, a clear understanding of the possible health effects of nanoparticles are still not clear resulting in limitations to the widespread use of these clearly extraordinary nanobiotechnologies.

**VII. CONCLUSION**

Nanobiotechnology is a global business enterprise which has great impact on universities, industries and regulation agents. Nanobiotechnology is still in its early stages of development and expansion, however, the development is rapid and multidirectional. It will provide opportunities to develop new materials and methods that will enhance our ability to develop faster, more reliable and more sensitive analytical systems. Although there are many exciting potential biological applications of nanomaterials and expectations from nanobiotechnology are high, the safety of it is not yet fully defined. One needs to discern genuine scientific promises from hype and to constantly improve the fundamental understanding of the interaction of nanomaterials and intracellular structures, the process and the environment. Therefore, detailed research and careful clinical trials are required to introduce diverse tools of nanobiotechnology in random clinical applications with potential success.

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