NANOBIOTECHNOLOGY

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ABSTRACT

Nanobiotechnology is an emerging branch of 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 leads to significant improvement in various techniques like drug delivery, food processing, tissue engineering 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 understood or defined yet.

Keywords—nanobiotechnology, medical science, nanoparticles

**I.INTRODUCTION**

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

Nanobiotechnology has a huge scope of advancement in various areas of life. It also provides new opportunities for development in medicine, environment, agriculture, industry, food, etc. Nanoscale materials and structures namely nanoparticles, nanofibers, nanotubes, etc have been experimented in various techniques like biosensing, anticancer therapy, gene therapy, molecular imaging, etc. Since nanobiotechnology can deal with so many disciplines, it attracts the researchers and scientists to develop more materials and structures related to it.³ This new field of science can improve our health, industries and our society in a much better way than we can ever imagined. It will have a diverse and rapid growth in near future.

**II. BACKGROUND HISTORY**

On 29 Dec 1959, Richard Feymaan gave a lecture at the California Institute of Technology on the topic “There is plenty of room at the bottom”where he proposed the idea of building objects from the bottom up by directly manipulating atoms. This idea is considered to be the birth of science at the nanolevel. In 1986, Eric Drexler published “Engines of creation”, where he emphasized on the potentials and scopes of nanobiotechnology. He is actually responsible for the term nanotechnology to acquire its current sense.

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. At this range, scientists can design atoms to create much lighter, efficient and 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. These applications give origin of the term “nanobiotechnology”, a unique combination of biotechnology and nanotechnology.

**III. APPLICATIONS OF NANOBIOTECHNOLOGY**

1. MEDICAL APPLICATIONS

A) DIAGNOSIS: Nanoparticles around 25nm gold combined with anti epidermal growth factor receptor monoclonal antibodies can be efficiently used as cancer detecting markers, specially epidermal growth factor receptors. It can be used as sensors for detection of sensitive DNA. Nanomaterials like dendrimers, nanosized metal oxides are used as contrast agent in medical imaging tools like CT, MRI, etc. It results in a dramatic increase in signal contrast compared to other antibody fluorescent dye targeting agents.

B) THERAPEUTIC: Cancer treatment using nanoparticles have abilityl of faster destruction of the tumor cells with less damage to a normal tissues and hence the potential of standard chemotherapy and irradiation are increased. Applied nanobiotechnology in collaboration with advanced neurophysiology, nanopathology and cell biology is used for regeneration and protection of the central nervous system. Drug delivery using nanomaterials has lesser side effects, require lower dose, more efficient and has higher bioavailability. Nanoprobes can detect plaque components and to find out maximum risk in case of cardiovascular diseases. Antimicrobial nanoemulsions, consisting of alcohol, water, soybean oil, detergent agents can destroy the micro-organisms effectively without any adverse effects.⁴

C). GENE THERAPY: Since nanodevices has the ability to enter cells more easily than the larger devices, it has better interaction and works effectively with the cells. Gene therapy using nanotechnology can now replace the currently used viral vectors with potentially less immunogenic nanosize gene carriers. Nanosize materials can be introduced successfully in delivery of repaired genes or replacement of incorrect genes. In gene delivery, nanoparticles has many advantages like: the structure of the nanoparticles protects the nucleic acids from degradation by nucleases and the environmental factors; directs the nucleic acid to the specific location of action and hence minimizes the side effects; nanoparticles can perform gene delivery for longer periods.

D). DRUG DELIVERY: Drug delivery system using nanoparticles and devices has higher solubility, more bioavailability, lesser instability of drug, lesser 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 drug delivery systems using nanobiotechnology principles includes- Administration of Doxorubicin in cancer therapy, using nanocarriers like liposomes penetrates the tumors passively thereby enhancing the efficiency of the active product ingredient therapeutically with minimized adverse effects. Drug delivery vehicles under investigstion include dendrimers, nanoshells, micelles, etc.

1. TISSUE ENGINEERING

Here, damaged or injured tissues or cells is reconstructed by the use of biomaterials, growth factors, cell therapy, biopolymers, etc which can act as the support for the cell development. Electro-spinning technique is widely used for construction of biomaterials to be cultivated with cells.

1. PATHOGEN DETECTION

Food borne pathogens need to be monitored throughout i.e., from its production till the point of sale. Elemental silver and silver salts can be used as antimicrobial agents for curing and preventing various health problems. The principle behind antimicrobial action of the silver salts and complexes is the bonding of the metallic ions in various biomacromolecular components. Therefore, these nanopartices can be used as care system for human health in pathogen detection.

1. FOOD SAFETY

Nanobiotechnology is involved in food packaging mainly by adding antioxidants, antimicrobials, biosensors, and other nanomaterials. Due to its antimicrobial property, silver and related materials have been utilized in many nanobased commercial products. The antimicrobial performance is increased due to an intensive surface area/reduced particle size. Natural biopolymer-based nanocomposite films are used for food packaging for safe storage;for detection of microbial pathogens, nanowire immunosensors are used; 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 now in an infancy stage of development. However, its development is going multidirectional and very rapid. Investment for development in nanotechnology is now receiving full support and fundings from governments, research centres and various companies. The areas of potential development are manufacturing and use of novel nanomaterials and nanostructures, analytic methods and instruments for studying single biomolecules, devices and nanosensors for the early detection of diseases and pathogens, identification of novel biologic targets for imaging, diagnosis and therapy and nanotechnology for tissue engineering. Recently, patients have received whole cultured bladders using nanobiotechnology principles. With the advancement, it has now become possible to grow a uterus in in-vitro conditions and then transfer it into in-vivo conditions in the body. In the United States, many clinical trials are undergoing on stem cell treatments to cure cardiac diseases. Many researches are trying to synthesize new limbs in patients without having to resort to prosthesis. Fluorescent polymer coated nanospheres is a popular example nowadays, 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 are still there in the commercialization of nanomaterials, Eg., 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). Follow up and monitoring of humans and animals exposed to the environment potentially contaminated with nano-materials are required to be check for any adverse consequences.

B). Detection and determination of the level of toxicity of engineered nanomaterials.

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

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

E). Development of tools to assess the 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 and become free to participate in various biological and chemical processes. Nanoparticles, due to its extreme microscopic dimension have potential hazards similar to that of the 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 carried out. These studies include analysis of the effect of physiochemical properties of cell bioavailability, uptake and bioprocessing. Studies also required to be made to optimise these particles for their utility in nanomaterials for therapeutic use. Numerous studies are undergoing on the toxic effects of nanomaterials. However, a clear knowledge of the possible hazards and risks of nanoparticles are still not there, resulting in restriction 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, its advances are beginning to change the landscape medicine. There is high hope that it will develop new materials and methods that will develop faster, more reliable and more sensitive analytical systems. Although there are various potential applications of nanomaterials and also expectations from nanobiotechnology are high, the safety of it is poorly defined. One needs to evaluate thoroughly the 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, proper and in depth concrete researches and diligent clinical trials are required to introduce diverse tools of nanobiotechnology in random clinical applications with potential success.

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