NANOBIOTECHNOLOGY

Abstract

Nanobiotechnology is an emerging branch of science which uses nanotechnology in the biological field. It uses biological materials which are in nanosize range. It has applications in various aspects of life as in 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.

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Authors

Davina Hijam
Associate Professor
Department of the Biochemistry
Regional Institute of Medical Sciences
Imphal, Manipur
davina_hijam@yahoo.co.in

Sunie Laishram
Post Graduate Trainee
Regional Institute of Medical Sciences
Imphal, Manipur

I. INTRODUCTION

Nanobiotechnology, a combination of nanotechnology and biotechnology, is the development, design and implementation of nanomaterials and devices that deals with the functional and chemical processes of biological agents. It is a multidisciplinary area that includes a broad range of technological areas from engineering, chemistry, physics, and biology.

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 researchers and scientists to develop more materials and structures related to it. This new field of science can improve our health, industries and our society in a much better way than we can ever imagine. It will have a diverse and rapid growth in the near future.

II. BACKGROUND HISTORY

Richard Feymaan proposed the notion of making anything from the bottom up via directly manipulating atoms in a talk titled "There is plenty of room at the bottom" on December 29, 1959, at the California Institute of Technology. This concept is regarded as the beginning of nanoscience. The promise and extent of nanobiotechnology were highlighted in Eric Drexler's 1986 book "Engines of Creation." He is actually responsible for the term nanotechnology to acquire its current sense.

According to the National Nanotechnology Initiative, nanotechnology is the study of atoms, molecules, or macromolecules to produce systems, structures, and technologies that are smaller than 100 nanometers. At this range, atoms are arranged to produce materials that are more lighter, more effective, and stronger with specific features. It seemed inevitable that nanotechnology will be used in the life sciences since the biological processes that make up live cells have intrinsic nanoscale functionalities. These applications give the origin of the term “nanobiotechnology”, a unique combination of biotechnology and nanotechnology.

III. APPLICATIONS OF NANOBIOTECHNOLOGY

1. Medical Applications

- **Diagnosis:** Particularly for epidermal growth factor receptors, 25 nm gold nanoparticles and anti-epidermal growth factor receptor monoclonal antibodies are combined together to detect cancer It can be used as sensors for detection of sensitive DNA. Nanomaterials like dendrimers and nanosize metal oxides are used as contrast agent in medical imaging tools like CT, MRI, etc. Compared to other antibody fluorescent dye targeting agents, it produces a striking increase in signal contrast.

- **Therapeutic:** The effectiveness of conventional chemotherapy and radiation therapy is boosted when cancer is treated with nanoparticles because they have the capacity to more quickly destroy tumour cells while causing less harm to normal tissues. Applied nanobiotechnology in conjunction 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. Alcohol, water, soybean oil, and detergent ingredients may efficiently kill microorganisms without causing any negative side effects when combined to form antimicrobial nano emulsions.

- **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. Nanosize gene carriers with potentially less immunogenicity can replace the currently used viral vectors. Nanosize materials are introduced successfully to deliver corrected genes or substitute defective genes. In gene delivery, nanoparticles have many advantages like: the structure of the nanoparticles protects the nucleic acids from environmental factors and nuclease degradation; the nucleic acid is directed to the desired location, minimising side effects; and the nanoparticles can carry out gene delivery for longer periods of time.

- **Drug delivery:** The drug delivery system using nanoparticles and devices has higher solubility, more bioavailability, decreased drug instability, and decreased adverse effects. Generally, the drug delivery system using this technique employs components like drug, a substance encasing the drug and surface coating components. Examples of medication delivery methods based on nanobiotechnology include the administration of doxorubicin in cancer treatment, which uses nanocarriers like liposomes to passively enter tumours and increase the therapeutic effectiveness of the active product ingredient with minimal side effects. Drug delivery vehicles under investigation include, dendrimers, nanoshells, micelles, etc.

2. **Tissue engineering:** Here, damaged or injured tissues or cells are reconstructed using biomaterials, growth factors, cell therapy, biopolymers, etc which act as the supporting materials for cell development. Electro-spinning technique is widely used for construction of biomaterials to be cultivated with cells.

3. **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 bonding of metallic ions in various bio-macromolecular components is the principle behind antimicrobial action of the silver salts and complexes. Therefore, these nanoparticles can be used as care system for human health in pathogen detection.

4. **Food safety:** Nanobiotechnology is involved in food packaging mostly by the addition of antioxidants, antimicrobials, biosensors, and other nano-materials. Due to its antimicrobial property, silver and its associated materials have been put into use in many nano-based commercial products. The antimicrobial action is increased due to an

intensive surface area or smaller particle size. Natural biopolymer-based nanocomposite films are used for food packaging for safe storage and for noting microbial pathogens. Nano-wire immunosensors as a blocking agent of UV light in plastic packaging are used for quick detection of food-borne pathogens.

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 nano-materials and nano-structures, analytic methods and instruments for studying single biomolecules, devices and nano-sensors for the early detection of diseases and pathogens, identification of novel biologic targets for imaging, diagnosis and therapy and also nanotechnology for tissue engineering.

Recently, transplantation of whole cultured bladders in patients is done using nano-biotechnology principles. With the advancement, it has now become feasible to grow a uterus in in-vitro conditions and then transfer it into in-vivo conditions in the body. Many clinical trials are undergoing in the United States on stem cell treatments to cure cardiac diseases.

Many researches are trying to synthesize new limbs in patients without having to fall back on to prosthesis. Fluorescent polymer coated nanospheres is a popular example nowadays, where fluorescence of polymer is extinguished when they encounter with specific molecules. The polymer-coated spheres someday as part of new biological assays may be introduced into the human body in locating the metabolites associated with various diseases like tumors. But multiple challenges are still there in the commercialization of nano-materials, 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

1. Follow up and monitoring of humans and animals exposed to the environment possibly contaminated with nano-materials are required to be checked for any adverse consequences.
2. Detection and determination of the level of toxicity of engineered nanomaterials.
3. Proposing and introducing models for checking and predicting the outcome of the nano-materials on human health and the environment.
4. Assessing the impact of engineered nano-materials on the environment and human health over an entire life span.
5. The development of tools to evaluate the risk to human health and to the environment. Commercialization challenges of nano-biotechnology include unreliability of efficiency of innovation, scalability, funding, scarce resources, patience, etc.[5]

VI. NANOTOXICITY

Since the size of the molecules or atoms are thin and small, a great proportion of the molecules or atoms that form a nanoparticle are uncovered and become free to participate in

various biological and chemical processes. Nanoparticles have potential hazards due to its extreme microscopic dimension similar to that of particulate matters. These particles have the capability to cause various diseases of different systems of the body.

In order to better understand the hazards of materials and develop safer nano-materials, studies in the nano-bio-interface 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 nano-materials for therapeutic use. Numerous studies are undergoing on the toxic effects of nano-materials. 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 nano-biotechnologies.

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 mature faster, more authentic and more sensitive analytical systems. Although there are various possible applications of nano-materials and also expectations from nano-biotechnology are high, its safety is poorly defined. One needs to evaluate thoroughly of the genuine scientific promises from promoting the hype and to constantly improve the fundamental understanding of the interaction of nano-materials, intracellular structures, the process and the environment. Therefore, proper and in detailed concrete researches and diligent clinical trials are required to initiate various tools of nano-biotechnology in random clinical applications with promising success.

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