Application of Nanotechnology to Pharmaceutical and Food Industry

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Abstract: **Nanotechnology is a fast growing, broad area of science that lies within the intersection of medicine, chemistry, physics, biology, computer science, information technology and material sciences. In the next decade Nanotechnology will touch the life of each and every human on this planet and revolutionize life all over the globe by generating clean energy, improving food supplies, fighting diseases, water purification etc.**

Keywords**: Nanotechnology, nutrition, pharmaceutical science, nano particles, nano assembly.**

INTRODUCTION

The innovations and research of building devices and materials on the scale of atoms and molecules is referred to as NANOTECHNOLOGY. One nanometer is equal to one billionth of a meter. The size/scale can be well imagined by the fact that diameter of a single human hair is approximately 80,000 nanometers. Thickness of average sheet of newspaper is about 100,000 nanometers. The usual law of physics and chemistry cannot be applied at nanoscale. It has been reported that characteristics of materials e.g. strength, conductivity, reactivity and even colour are entirely different in nanoscale and macroscale. This is due to the reason that surface to volume ratio of nanoparticles is high. Use of Nanotechnology is extended to find new and innovative methods to produce new materials, to formulate novel chemicals and to substitute the currently used equipments with equipments which use lesser energy and material and hence are environment friendly. Nanotechnology finds its application in agricultural, nutritional, pharmaceutical and medical science.

This technology can increase the energy efficiency, help in reducing pollution levels and is very effective in solvinga lot many health issues. Manufacturing and production of umpteen number of items can be increased extensively at reduced costs. Nanotech scientists claim that particles produced by this technology are smaller, lighter, cheaper and more beneficial.

HOW IT STARTED

A talk entitled "There is plenty of room at the bottom" was delivered by renowned Physicist Richard Feynman (Father of Nanotechnology) at California Institute of Technology in December, 1959. He described a process wherein scientists can control and manipulation of individual atoms and molecules becomes feasible. It was a decade later Professor Norio Taniguchi coined the term Nanotechnology. During early eighties with the help of scanning Tunneling Microscope (STM) and Atom Face Microscope (AFM) individual atoms could be seen and age of Nanotechnology was born.

An analogy to nanotechnology can be drawn from the way life began billions of years ago. The first form of life contained RNA, DNA and genes which stored within them the basic information for life. These building blocks hold all the coded information needed to produce similar systems. This property is interpreted and nano assembly is created.

BENEFITS AND APPLICATIONS

Nanotechnology finds its usage in varied industries and is revolutionizing, improving and delivering in expected and most unexpected ways in sectors like transportation, information technology, homeland security, food safety, medicines and environmental science to name a few.

A. Pharmaceutical and Medical Application

Therapies currently available as well as the usage of medical tools is broadened by the usage of Nanotechnology. Nanomedicines are beneficial for disease prevention as well as its treatment. Nanoparticles are known to influence characteristics such as solubility, decreased toxicity, bio-availability and drug releasing ability which has led to the development of some of the influential drug systems. Nano sized drugs are better than conventional drugs as they have large surface areas, superior performance and ability i.e. enhanced rate of dissolution, increased solubility, oral bioavailability, low required dosages, fast therapeutic action, less patient to patient variability. This gives increased safety and more efficacy and more scope for targeted drug delivery systems.

Nanomaterials have more biocompatibility with living cells and hence finds usage in tissue engineered products Nanomaterials are also used for drug encapsulation, bone replacements, prosthesis and implants. This depends on the morphology and shapes of nano-systems. Some of the advances and applications of nano-medicines are already in use, some of these are as follows:

a) Nanotechnology is used for diagnosis and treatment of artherosclerosis (formation of plague in arteries). Scientists have created nanoparticles that mimic the good cholesterol called HDLC (High Density Lipoproteins) which helps to reduce plague. Nanoparticles can encapsulate and thus help to deliver medication directly to carcinogenic cells. This helps in minimizing the risk to damage the healthy cells in the vicinity. It thus brings down the toxic effects of chemotherapy. Nanotechnology has found an important application in preventing and combating the metastases process, thus helping in better treatment of cancer. Metastases

is development and formation of carcinogenic cells from their primary mass to other parts of the body in form of secondary tumors. This is one of the major challenges facing oncologists as it happens in almost all the cancers. The difficulty faced in treating metastases is due to their minute size, high multiplicity rate and fast dispersion to diverse organ environments. Moreover only a few known treatment methods can reach very specifically to the carcinogenic cell hence doubts arise over their efficacy. Nanotechnologists have solved this issue to a great extent by using smart nanomaterials which combine multiple therapeutic functions and applications into a single platform so as to target specific cells and become accessible to specific subcellular compartments. Although this technology is already in use to treat specific cancer cells, spread of cancer and metastases can also be controlled by this technology.

b) Nanotechnology has paved the way for providing better imaging and diagnosis for better individualized treatment and better therapeutic success.

c) Gold nanoparticles have found commercial application as probes for detecting the sequence of nucleic acid gold. It has been clinically proven that gold nanoparticles have potential to treat cancer and other diseases.

d) Nano-medicine scientists have found ways to improve efficacy of vaccines and its delivery without the use of needles. Researchers have come up with a very novel idea of formulating a universal vaccine that would cover more strains and require less resources to develop especially when vaccines are to be given annually.

B. Application of nanotechnology in nutrition –

Healthy diet is essential to sustain a healthy life. The food is essential to sustain a healthy life. The food ingested by any organism is broken down and through this metabolic pathway energy is released and life sustained. Nanotechnology has influenced almost all sectors of agricultural systems and food industry like disease treatment, delivery systems, food security, novel tools for cellular and molecular biology, designing pathogen and contamination technique and protection of environment by using green safe nano techniques. Encapsulation and delivery of food ingredients to specific desired sites is an added achievement of nanotechnology in the food industry. Food nanotechnology has opened new channels to enhance quality and quantity of crop and food products. Nanomaterials used as food additives can further improve the shelf life of products and also possess the potential to enhance the texture quality, nutrient composition and flavor. These additives can also be used to detect the contamination and pathogens if present in the product. Nanotechnology is known to increase the shelf life of the product and at the same time prevents the toxins and pathogens to grow by use of antimicrobial agents such as titanium-oxide, silver, zinc oxide and many more bio nanoparticles. The progression of Nanotechnology has also aided food and dairy manufactures, agricultural consumers and products to a large extent. Nanotechnology has made evolution in food packaging by improving food safety measures, alerts over presence of bacteria and other contaminants if present, maintaining color quality, producing stronger flavours and repairing tears if present in packaging. Extended release of preservatives to extend the shelf life of packaged food is another progress. Further biosensors can be developed by incorporating functional nanoparticles into biological cells which can target natural proteins or sugars.

Enhanced benefits from drugs and food to mankind has been achieved by availability of nano- based particles (in form of nanoscale capsules or nanoscale dispersion cells) which can targetvitamins, drugs, flavoring agents, antimicrobials, antioxidants, preservatives and coloring agents. To deliver polar, non-polar also amphiphilic functional ingredients in food and drug industry, nanotechnology is used for encapsulation of associated colloids, vesicles, surfactant micelles, bilayers and also liquid crystals.

Nanotechnology makes use of “Bottom Up”and “Top Down”methods. The top down procedure is used to physically process the food materials, whereas the bottom up approach is involved with building up larger structures from atoms and molecules. Simple example for the above is organization of starch or casein micelles and protein folding. In view of above it can be stated that Nanotechnology can be employed in numerous ways in the food and nutrition industry.

The innovations of nanotechnology are revolutionary and applications for engineered nano materials are developing at a rapid pace with this there is also concern about the awareness that needs to be spread in government, public groups and industries with regard to nano safety points. Public interest is growing whereas some groups have negative perception that nano materials are mushrooming in an unregulated manner and are being released without adequate safety related testing.

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