Nanotechnology Services Section Front Page

?Nanotechnology ("nanotech") is manipulation of matter on an atomic, molecular, and supramolecular scale.Nanobiotechnology is the application of nanotechnology in biological fields. Nanotechnology is a multidisciplinary field that currently recruits approach, technology and facility available in conventional as well as advanced avenues of engineering, physics, chemistry and biology. Applications: The pathophysiological conditions and anatomical changes of diseased or inflamed tissues can potentially trigger a great deal of scopes for the development of various targeted nanotechnological products. This development is like to be advantageous in the following ways: 1. Drug targeting can be achieved by taking advantage of the distinct pathophysiological features of diseased tissues [3]; 2. Various nanoproducts can be accumulated at higher concentrations than normal drugs [4]; 3. increased vascular permeability coupled with an impaired lymphatic drainage in tumors improve the effect of the nanosystems in the tumors or inflamed tissues through better transmission and retention [5,6]. 4. Nanosystems have capacity of selective localization in inflammed tissues [7]. 5. Nanoparticles can be effectively used to deliver/transport relevant drugs to the brain overcoming the presence of blood–brain barrier (meninges) [8,9]. 6. Drug loading onto nanoparticles modifies cell and tissue distribution and leads to a more selective delivery of biologically active compounds to enhance drug efficacy and reduces drug toxicity. A number of clinical applications of nanobiotechnology, such as disease diagnosis, target-specific drug delivery, and molecular imaging are being laboriously investigated at present. Some new promising products are also undergoing clinical trials [12,13]. Such advanced applications of this approach to biological systems will undoubtedly transform the foundations of diagnosis, treatment, and prevention of disease in future. Some of these applications are: - Diagnostic applicationsCurrent diagnostic methods for most diseases depend on the manifestation of visible symptoms before medical professionals can recognize that the patient suffers from a specific illness,Nucleic acid diagnostics will play a crucial role in that process, as they allow the detection of pathogens and diseases/diseased cells at such an early symptomless stage of disease progression that effective treatment is more feasible. Current technology, such as- polymerase chain reaction (PCR) leads toward such tests and devices, but nanotechnology is expanding the options currently available, which will result in greater sensitivity and far better efficiency and economy. - Protein chipsProteins play the central role in establishing the biological phenotype of organisms in healthy and diseased states and are more indicative of functionality. Hence, proteomics is important in disease diagnostics and pharmaceutics, where drugs can be developed to alter signaling pathways. -Sparse cell detectionSparse cells are both rare and physiologically distinct from their surrounding cells in normal physiological conditions (e.g. cancer cells, lymphocytes, fetal cells and HIV-infected T cells). They are significant in the detection and diagnosis of various genetic defects. However, it is a challenge to identify and subsequently isolate these sparse cells. Scientists developed nanosystems capable of effectively sorting sparse cells from blood and other tissues. This technology takes advantage of/exploits the unique properties of sparse cells manifested in differences in deformation, surface charges and affinity

for specific receptors and/or ligands. For example, by inserting electrodes into microchannels, cells can be precisely sorted based on surface charge. -Therapeutic applications:Nanotechnology can provide new formulations of drugs with less side effects and routes for drug delivery. -BiopharmaceuticalsNanobiotechnology can develop drugs for diseases that conventional pharmaceuticals cannot target. Future: The pharmaceutical industry traditionally focuses on developing drugs to treat a defined universe of about five hundred confirmed disease targets. But approximately 70 to 80 percent of the new candidates for drug development fail, and these failures are often discovered late in the development process, with the loss of millions of dollars in R&D investments. Nanoscale techniques for drug development will be a boon to small companies, which cannot employ hundreds of organic chemists to synthesize and test thousands of compounds. Nanobiotechnology brings the ability to physically manipulate targets, molecules and atoms on solid substrates by tethering them to biomembranes and controlling where and when chemical reactions take place, in a fast process that requires few materials (reagents and solutions). This advance will reduce drug discovery costs, will provide a large diversity of compounds, and will facilitate the development of highly specific drugs.Nanotechnology in cardiac therapyNanotechnology is currently offering promising tools for applications in modern cardiovascular science to explore existing frontiers at the cellular level and treat challenging cardiovascular diseases more effectively. These tools can be applied in diagnosis, imaging and tissue engineering [36]. Miniaturized nanoscale sensors like quantum dots (QDs), nanocrystals, and nanobarcodes are capable of sensing and monitoring complex immune signals in response to cardiac or inflammatory events [20]. Nanotechnology can also help detect and describe clinically-significant specific mechanisms implicated in cardiac disorders. In addition, it is useful in designing atomic-scale machines that can be incorporated into biological systems at the molecular level. Introduction of these newly designed nanomachines may positively change many ideas and hypotheses in the treatment of critical cardiovascular diseases. Nanotechnology could also have great impact in tackling issues like unstable plaques and clarification of valves. Thus, this approach could be a real milestone of success in achieving localized and sustained arterial and cardiac drug therapy for the management of cardiovascular diseases. Continuous advancements in nanomedicine have opened up its opportunities for application in a variety of medical disciplines. Its future application as diagnostic and regenerative medicine is currently being investigated. In diagnosis, detection of diseased cells would be faster, possibly at the point of a single sick cell, while allowing diseased cells to be cured at once before they spread into and affect other parts of the body. Also, individuals suffering from major traumatic injuries or impaired organ functions could benefit from the use of nanomedicine. Challenges: No single person can provide the answers to challenges that nanotechnology brings, nor can any single group or intellectual discipline. The five main challenges are to develop instruments to assess exposure to engineered nano-materials in the air and water. It is fairly understood that exposure of humans and animals to the environment potentially contaminated with nano-materials may need to be monitored for any adverse consequence. The challenge becomes increasingly difficult in more complex matrices like food. The second challenge would be to develop applicable methods to detect and determine the toxicity of engineered nano-materials within next 5 to 15?years. Then again, proposing models for predicting effects of these nano-materials on human health and the environment would be an inevitable issue. The next challenge would be to develop reverse systems to evaluate precise impact of engineered nano-materials on health and the environment over the entire life span that speaks to the life cycle issue. The fifth being more of 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. A broad majority of company recognizes a great potential in nanotechnology for the development of new products and the improvement of existing products. A new potentially disruptive technology like nanotechnology raises fundamental questions about the need for new regulations. Authorities around the world should evaluate possible risks and an appropriate regulatory response to the extensive use of this advanced technology. Nanoparticles, as a result of their extreme microscopic dimension, which gives unique advantage, have potential hazards similar to particulate matters [50]. These particles have the potential to cause varied pathologies of respiratory, cardiovascular and gastrointestinal system [51]. Intra-tracheal instillation of carbon nanotube particles in mice has shown that carbon nanotubes have the potential to cause varied lung pathologies like epitheloid granuloma, interstitial inflammation, peribronchial inflammation and necrosis of lung. The toxicity produced by carbon nanotube was found to be greater than that produced by carbon black and quartz. The toxicity of nanoparticles can also be extrapolated to gastrointestinal system, resulting in inflammatory bowel diseases. The toxicity of nanoparticles may be related to its ability to induce release of pro-inflammatory mediators resulting in inflammatory response and organ damage. If ingested, the nanoparticles can reach the circulation and reach different organs and systems and possibly result in toxicity [58]. These have been studied in vitro and in animal models and the effect on human system is difficult to extrapolate from such studies. Their use in humans requires further research and much needed caution. Market demand: Nanotechnology as an industry has crept into several other major industry topics covered by BCC Research. The innovation and emerging nanotechnologies have significantly reshaped the manufacturing, biotechnology, environmental and pharmaceutical markets. Nanoparticles, nanotubes, nanocomposites and nanoclays are all covered within BCC Research reports. In-depth market analysis of these technologies as well as trends, forecasts and profiles of major players prove how valuable the growth of nanotechnology has become. Efficiency of nanotechnology has led to great discoveries in prescription drug products, photonics and has had a great environmental impact in the water treatment and decreasing the amount of pollutants that deplete the environment. Use of nanotechnology in medical therapeutics needs adequate evaluation of its risk and safety factors. Scientists who are against the use of nanotechnology also agree that advancement in nanotechnology should continue because this field promises great benefits, but testing should be carried out to ensure the safety of the people. It is possible that nanomedicine in future would play a crucial/unparallel role in treatment of human diseases and also in enhancement of normal human physiology. If everything runs smoothly, nanobiotechnology will, one day, become an inevitable part of our everyday life and will help save many lives. Nanotechnology is poised to impact dramatically on all sectors of agribusiness industry in the next 10 years. Nanotechnology could be used to enhance the possibilities of developing conventional and stranded agribusiness resources. Nanotechnology can make the industry considerably greener and competitive, with its current growth rate of 25% (US$ 1.08billion) annually. The opportunity for application of nanotechnology in agricul¬ture is prodigious. Nanotechnology, focusing on special properties of materials emerging from nanometric size has the potential to revolutionize the agricultural and food sectors, biomedicine, environmental engineering, safety and security, water resources, energy conversion, and numerous other areas. It is well recognized that adoption of new technology is crucial in accu-mulation of global wealth and market value which now stand at US$ 1.09 trillion in estimated value. Nanotechnology has emerged as a technological advancement that could develop and transform the entire agri-food sector, with the potential to increase agricultural

productivity, food security and economic growth for industries by atleast 30% (Aver. US$0.9 trillion) Commercial Opportunities and Market Demand for Nanotechnologies in Agribusiness Sector.