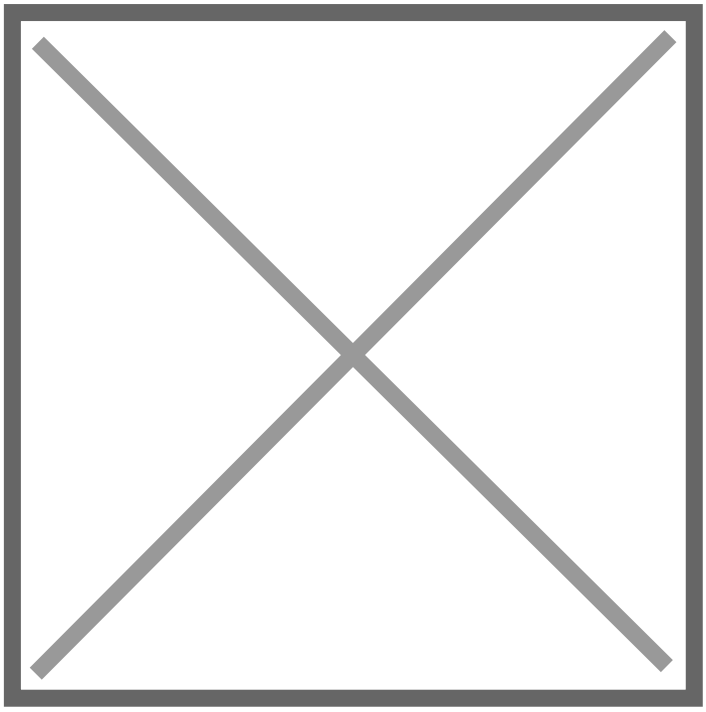
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# Nanobiotech gets increased attention

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*Nanobiotech is slowly gaining momentum in India. ASSOCHAM recently organized a forum on nanotechnology in Delhi and Karnataka has announced a nano event, Nano 2007, that will be held in December. The signs are promising.*

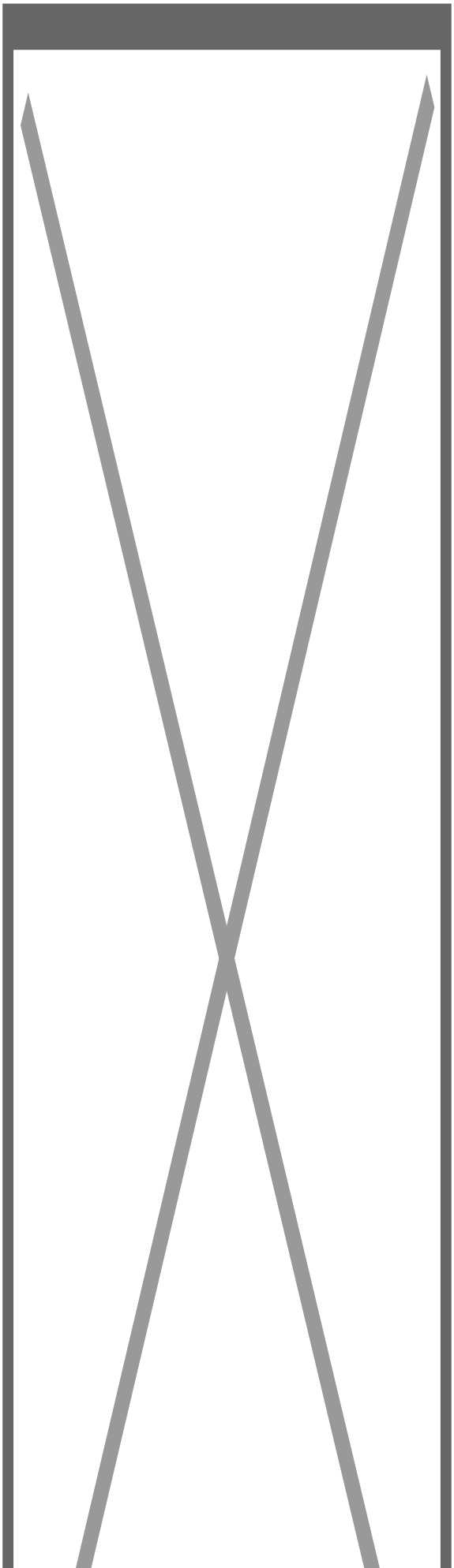
In January this year, Dabur Pharma launched a novel nanotechnology-based drug delivery system, Nanoxel, for the anti-cancer drug paclitaxel. This nanoscale drug delivery system is India's first indigenously developed nanotechnology based chemotherapy agent. The anti-cancer drug Nanoxel, based on the principles of nanotechnology, is a cremophor-free water soluble formulation and is indicated as an effective and safe therapy for advanced breast, non-small-cell lung, and ovarian cancinomas.

Dr Anand Burman, chairman, Dabur Pharma, at the launch said, "We are very excited to launch the first nanoparticle drug delivery system outside of the US." The company has two patents for the drug delivery system and formulation and started the nano-based research in 1997 and now has about 10 molecules in the pipeline according to Dr Rama Mukherjee, president, R&D, Dabur Research Foundation.

Dr Burman did not wish to speculate on the revenues the product would generate but said that the new product was superior and would take over conventional formulations, although the company was not considering phasing out its own existing paclitaxel products. This is one of the first cases of nanotech-based products coming out of India.

### Global nanobiotech market

Experts project a $3 billion worldwide market by 2008, with an annual growth rate of 28 percent. The US market will generate 65 percent of global demand for nanobiotech products, market research experts predict. Nanotech is estimated to be a $1-trillion global market by 2015.



Diagnosing and treating cancer is a major focus of many nanobiotechnology researchers. Cancer clinics already use nanotechnology such as liposomes that deliver treatment to specific tumor sites and DNA chips that make it easier to read large numbers of genes at a time for key diagnostic information.

A tremendous value of nanotechnology applications to cancer treatment is development of the ability to dramatically reduce or to eliminate side effects by precisely targeting treatment to only diseased cells and leaving healthy cells alone.

Nanotechnology has still a long way to go. The main reason for such a big hype over nanobiotechnology is the benefits it can bring to medical advancement, at least in theory. When one talks about nanobiotechnology and nanomedicine, one means enhanced drug solubility--the ability of particles to cross biological lipid membranes to enter cells and cross the blood brain barrier. However, this comes at a price as the quantum dots in the nanoparticles pose potential health risks for humans. For example, it has been reported that water-soluble fullerene molecules (nanomaterials) can cause brain damage in largemouth bass. Similarly, dendrimers (another nanomaterial) have been shown to cause osmotic damage, activate the clotting and complement systems and rip off membranes. Moreover, nano particles composed of metals such as selenium, lead and cadmium can be toxic to organisms if these metals manage to leak out of the particles. In addition, one school of thought believes that nanoscale materials neither act like particles nor like chemicals. The properties they possess could be anywhere in between (intermediate) or they could be totally unique.

Swapan Bhattacharya, managing director, TCG Life Sciences said that India has for long been fighting diseases like malaria, polio and cholera with blockbuster drugs from the West. But these drugs are not effective in majority of the population and also with more challenging diseases such as cardiovascular diseases and diabetes, the mission is to discover new and more effective drugs. But the drug manufacturers today are facing challenges like high cost of research, decreasing productivity and failure of drugs during clinical process and during marketing.

In order to meet the needs of the customer, the application of science has to change, and this is where personalized medicine, also referred to as translational medicine comes into play. We need to take information from clinic and patients to the drug discovery level.

"India is not at par when it comes to drug discovery because of lack of right regulatory environment and infrastructure facilities, but at the same time, we do have the right scientific talent. India has 27 new entities in different stages of clinical trials and given the genetic biodiversity that we have there is a lot of potential yet to be explored."

He further stressed that nano and biotechnology, physics and chemistry should converge to serve the purpose of advance science. Talking about the application of nanotechnology in the future and the synergy between biotechnology and nanotechnolgy, he concluded, "Nanotechnology is a tool whereas drug discovery is a process, the synergy can be achieved with nanotechnology helping in effective and targeted drug delivery that is something that we can look towards in the future."

The sheer breadth of nanobiotechnology and the expense of researching it requires strong collaboration between research institutions. In Texas, for example, nanobiotechnology research and development is conducted through a state-aided alliance of 15 universities in which all institutions contribute to the alliance and all share in the returns.

**Initiatives in India**

The New Millennium Indian Technology Leadership Initiative program of the Council of Scientific and Industrial Research (CSIR) is also promoting two public-private collaborative ventures for developing nanotechnologies that target drugs to exactly where they are needed in the human body.

In April 2004, former President Dr Kalam organized a meeting of nanoscience experts to devise a national mission plan. The experts recommended that $200 million be spent on nanotechnology over a five-year period. India's finance ministry has now cleared these funds for use in 2006-2011. From later this year, the new national mission will oversee activities currently under the Nano Science and Technology Initiative (NSTI).

The government has made a budgetary provision of Rs 1,000 crore to promote the sector. The Nano Science and Technology Initiative (NSTI) has funded about 100 basic science projects worth Rs 60 crore. This would also support establishing centres for nano science at several institutions such as the Indian Institute of Science, Bangalore, and different IITs.

The Amirta Center for Nanosciences was established in May 2006 as one of the seven nanotechnology centers funded by the Goverment of India under the Nanoscience and Nanotechnology initiative and is the only one in the biomedical area.

Sabeer Bhatia of "Hotmail" fame is investing $10 billion into the setting up of a "NanoCity" an environmentally sustainable development. It was unveiled in April 2006 by entrepreneur Bhatia and the Haryana state government. Modeled after Silicon

Valley, Nano City will feature R&D and educational centers and corporate offices for technology, biosciences and other knowledge industries.

**Nanotech implications**

The rise of nanotechnology is viewed to be a potent phenomenon in the biotechnology market and the positive trends can be marked on the stock market. High-level scientific research in the field has been bolstered by heavy capital investments pouring in on account of the great potential. It has also opened new avenues.

Nanobiotechnology applications are predominantly in the research and development phase. Over $3 billion in public funding was available worldwide for nanotechnology research in 2003, with around 8 percent dedicated to the nanobiotechnology sector according to some market reports. Public and private investment are sponsoring research projects in academia and facilitating the establishment of start-up and spin-off companies with the purpose of commercializing nanobiotechnology applications.

It is now the responsibility of the market participants to incorporate the technology in commercially viable products. Funding has been used to set up sound infrastructure, particularly in the US and Europe, for small companies to network and collaborate; but in India everything is still at very initial stages. It is essential for industry participants to be aware of what funding sources are available and where, as this indicates hot spots for business opportunities.

An increasing use of nanobiotechnology by the pharmaceutical and biotechnology industries is anticipated. Nanotechnology will be applied at all stages of drug development--from formulations for optimal delivery to diagnostic applications in clinical trials. Many of the assays based on nanobiotechnology will enable high-throughput screening. Some of nanostructures such as fullerenes are themselves drug candidates as they allow precise grafting of active chemical groups in three-dimensional orientations. The most important pharmaceutical applications are in drug delivery. Apart from offering a solution to solubility problems, nanobiotechnology provides intracellular delivery possibilities. Skin penetration is improved in transdermal drug delivery. A particularly effective application is as nonviral gene therapy vectors. Nanotechnology has the potential to provide controlled release devices with autonomous operation guided by the needs.

Nanomedicine is now within the realm of reality starting with nanodiagnostics and drug delivery facilitated by nanobiotechnology. Miniature devices such as nanorobots could carry out integrated diagnosis and therapy by refined and minimally invasive procedures, nanosurgery, as an alternative to crude surgery. Nanotechnology will markedly improve the implants and tissue engineering approaches as well.

Public expenditure for nanotechnology development in India stays around $7 million per annum as against $395.5 million of Germany, $301.1 million of France, $180 million in the UK, $ 233.5 million in South Korea and even $102.4 million Taiwan, according to The Associated Chambers of Commerce and Industry of India (ASSOCHAM).

Amazingly, India also fares relatively lower in funding of nanotechnology projects by the private sector. While the contributions of the private sector to the total funding vary from more than 50 percent in the US, 60-70 percent in Japan, and 36 percent across emerging Asian countries, that in India is close to 22 percent.

Europe leads the global nanotech based scientific publications by a share of almost 41 percent followed by the US and Canada with 24 percent, Japan 13 percent and rest of Asia Pacific with 14 percent. In India, the percentage is as meager as that of 8 percent according to ASSOCHAM. Despite all this, India's growth in nanotechnology is measured in double digit.

The UK has joined hands with India to establish a joint Nanotechnology Working Group to speed up the development of new technologies. The group will be officially launched within the next two months as part of the government's drive to promote the UK's nanotechnology sector on the international stage. The nanotechnology initiative between India and the UK will help create an environment that sparks co-operation.

The EuroIndiaNet FP6 funded project aims to promote stronger collaboration between EU and Indian scientists and industrialists in the areas of the nanosciences and nanotechnologies. The project aims to promote stronger collaboration between EU and Indian scientists and industrialists in the areas of the nanosciences and nanotechnologies through a comprehensive description of current policies, funding strategies, training programmes and support structures for nanotechnology R&D in both India and the EU.

**Nanobiotech companies**

A number of nanobiotechnology companies have emerged recently, that are looking at therapeutic benefits of nanomaterials.

Nano Cutting Edge Technology-Nanocet, a R&D nanobiotechnology company, is pioneering the development of uniquely advanced biostabilized nanoparticles technology in the areas of cancer hyperthermia, targeted drug delivery, diagnostics, antimicrobial agents and treatment of pollutants.

Qtech Nanosystems is a nanotechnology company, developing nanotechnology products for various applications, with the aim to propel innovation in Nanotechnology. Qtech Nanosystems aims to emerge as a premier collaborative research and new product development and launch center in nanotechnology achieving breakthroughs in technology, cross-functional collaboration and bringing best-of-class practices and knowledge to the forefront.

Qtech Nanosystems is not directly working on nanobiotech products as off now. It is basically working on products related to nanodynamics (precise control of "objects" in sub-nanometer scale), which in fact has applications in nanobiotechnology. Qtech is suspending its Indian operations and have shifted its corporate office to Singapore and shifting of R&D is in course.

Bangalore-based Velbionanotech is designing drugs for various diseases such as heart, kidney stones, AIDS, cancer, and cosmetic generic products using a short fragment of DNA as a new type of drugs. These drugs are assembled in nanochips and as nano particles for delivering in human body, which are affective in curing the sick/diseased and healing the injured.

VBN is working in new gene therapy procedures, DNA-based sensors, and other medical applications by using a new method developed to initiate and control chemical reactions on DNA strands. On the other hand silicon-based nanochips with itching and self-assembling techniques used to deliver drugs on the diseased molecules.

Although the benefits of nanobiotechnology are huge, there are certainly many hurdles ahead. Nanobiotechnology presents unique opportunities and challenges on the intellectual property front as well. Faced with many disappointments in the past, the main question still remains-will nanobiotechnology deliver the promises of biotechnology?

Jahanara Parveen