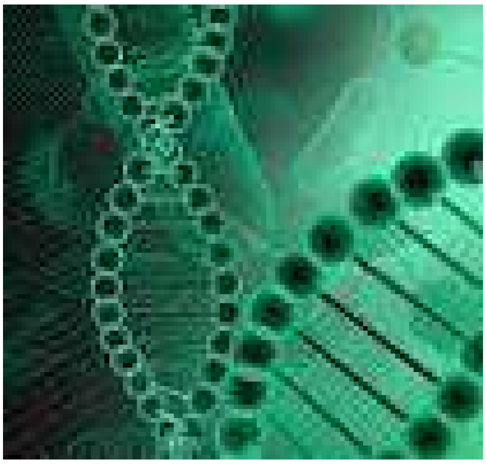
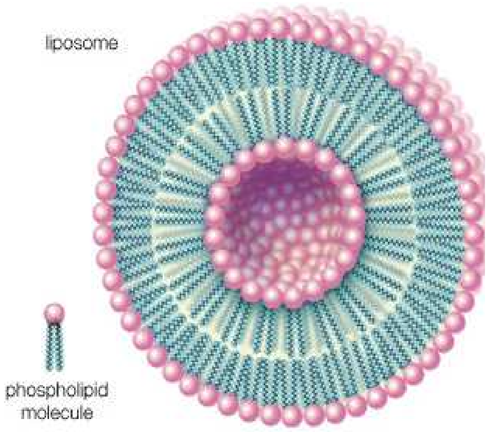
ENVIS CENTRE ON ENVIRONMENTAL BIOTECHNOLOGY

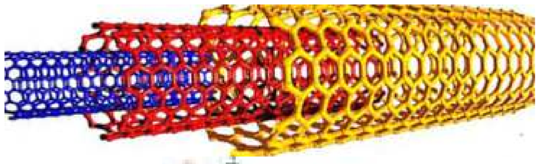
SUPPORTED BY MINISTRY OF ENVIRONMENT AND FORESTS
GOVERNMENT OF INDIA

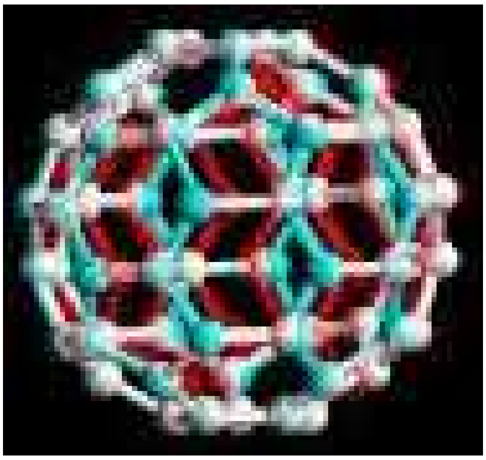
VOLUME-20 ISSN : 0974 2476 JUNE, 2012

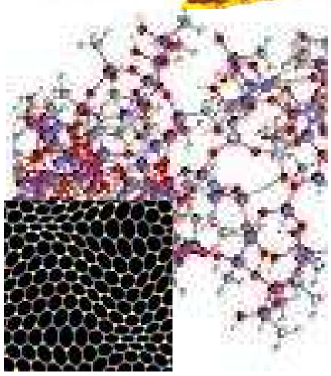
NEWS LETTER

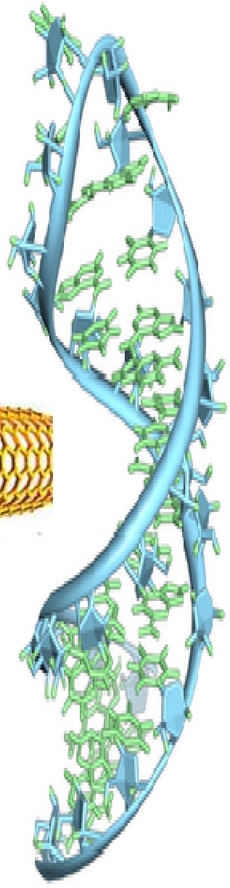












NANOBIOTECHNOLOGY

DEPARTMENT OF ENVIIRONMENTAL SCIIENCE, UNIIVERSITY OF KALYANI, NADIA, WEST BENGAL
Email: scsantra@yahoo.com, desku@envis.nic.in, Phone: +91-33-25828750, Ext:372
Telefax :+91-33-2580 8749,Website:http://www.deskuenvis.nic.in, www.kuenvbiotech.org

INSTRUCTIONS TO CONTRIBUTORS

ENVIS Newsletter on Environmental Biotechnology is a half-yearly publication publishes articles related to the thematic area of the ENVIS Centre. Popular or easily intelligible expositions of new or recent developments are welcome

Manuscripts should be typewritten (font should be Times New Roman and font size ought to be 12) on one side of the paper in double spacing with maximum of 6-8 typed pages

Figures and typed table should be in separate pages and provided with title and serial numbers. The exact position for the placement of the figures and tables should be marked in the manuscript.

Articles should be sent to

The Coordinator
ENVIS Centre
Department of Environmental Science
University of Kalyani, Kalyani-741235
Nadia, West Bengal
Email:**scsantra@yahoo.com, desku@envis.nic.in**

EDITORIAL

It has long been recognized that the physical form of materials can mediate their toxicity—the health impacts of asbestiform materials, industrial aerosols, and ambient particulate matter are prime examples. Yet over the past 20 years, toxicology research has suggested complex and previously unrecognized associations between material physicochemistry at the nanoscale and biological interactions. With the rapid rise of the field of nanotechnology and the design and production of increasingly complex nanoscale materials, it has become ever more important to understand how the physical form and chemical composition of these materials interact synergistically to determine toxicity. As a result, a new field of research has emerged—nanotoxicology. Research within this field is highlighting the importance of material physicochemical properties in how dose is understood, how materials are characterized in a manner that enables quantitative data interpretation and comparison, and how materials move within, interact with, and are transformed by biological systems. Yet many of the substances that are the focus of current nanotoxicology studies are relatively simple materials that are at the vanguard of a new era of complex materials.

In this newsletter (Vol. no. 20). We have attempted to discuss the nanobiotechnology related issues with respect to India.

(S. C. Santra)

IN THIS ISSUE:

Nanobiotechnology

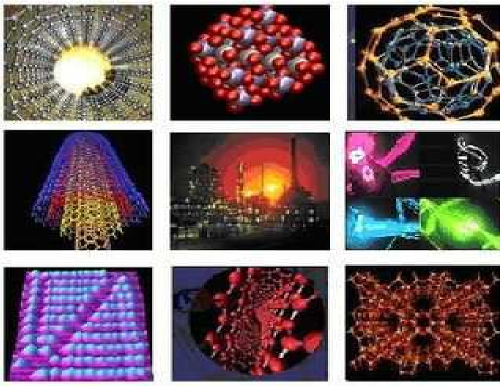
Nano-Science &Nanobiotechnology

Nanotechnology is the engineering of functional systems at the molecular scale. The science of the miniature-nanotechnology, though a relatively new field is fast emerging as the 'favourite of all' kind of technological arena due to its application in almost every field, from medicine to fabrics. 'Nano' in Greek means dwarf and material, when reduced to nano dimension (10^{-9}metre =1 nanometre) shows drastic changes in Physical, Chemical, magnetic, optical, mechanical and electrical properties. This promises exiting applications in bioscience, medical science, polymers sector, environment, electronics, cosmetics, security and variety of other fields.

The desire to harness cutting edge science and technology for enabling development has prompted global interest in emerging technologies such as information technology, biotechnology and of late nanotechnologies. Nanotechnology aims to harness the unique properties of things at the nanometer scale (one billionth of a meter) that are not displayed by their larger counterparts. Nanoscience generally deals with understanding the "nano" phenomenon and includes the investigation of the properties of various nanomaterials, control and maneuvering of matter at the nano scale. On the other hand nanotechnology involves using tools and methods for the synthesis, analysis, manufacture and application of materials, products and systems that are at the nanometer scale or incorporate facets of the same dimensions. However the term "nanotechnology" is by and large used as a reference for both nanoscience and nanotechnology especially in the public domain.

At present, though scientists are able to move molecules and atoms in a mass yet they are still not able to precisely manipulate them. But in future, nanotechnology will allow as redesign easily and create what we want exactly. Further, nanomaterials would be very light, strong, transparent, and totally different from bulk material because they are a thousand times smaller than the diameter of human hair, which is around 60 microns.

The examination and use of technology using nano particles that is as small as 100 nanometers and even smaller is called as **Nanotechnology**.



Nanosciences and Nanotechnology derived tools applied to study biological networks and physio-chemical processes have been welcomed by researchers all over the world. **Nanobiotechnology** is the branch of nanotechnology with biological and biochemical applications or uses. Nanobiotechnology often studies existing elements of nature in order to fabricate new devices. The term bionanotechnology is often used interchangeably with nanobiotechnology, though a distinction is sometimes drawn between the two. If the two are distinguished, nanobiotechnology usually refers to the use of nanotechnology to further the goals of biotechnology, while bionanotechnology might refer to any overlap between biology and nanotechnology, including the use of biomolecules as part of or as an inspiration for nanotechnological devices. Nano-biotechnology is that branch of one, which deals with the study and application of biological and biochemical activities from elements of nature to fabricate new devices like biosensors. Nanobiotechnology is often used to describe the overlapping multidisciplinary activities associated with biosensors particularly where photonics, chemistry, biology, biophysics nanomedicine and engineering converge.

Nanoparticles are mainly classified into three types: (i) Naturally occurring (Volcanic ash, sea spray, combustion by-product) (ii) Incidental /Ultrafine, (Fresh welding fume, freshly generated diesel exhaust) (iii) Engineered Manufactured (Nanotube, nanoscale titanium dioxide)

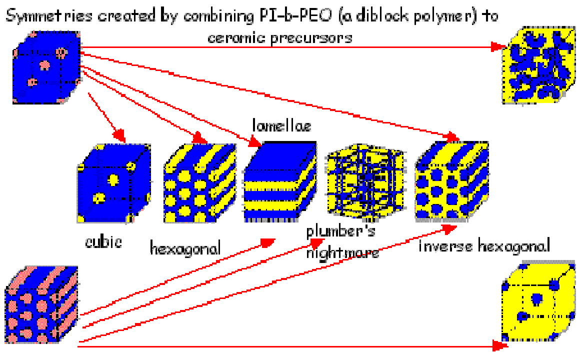


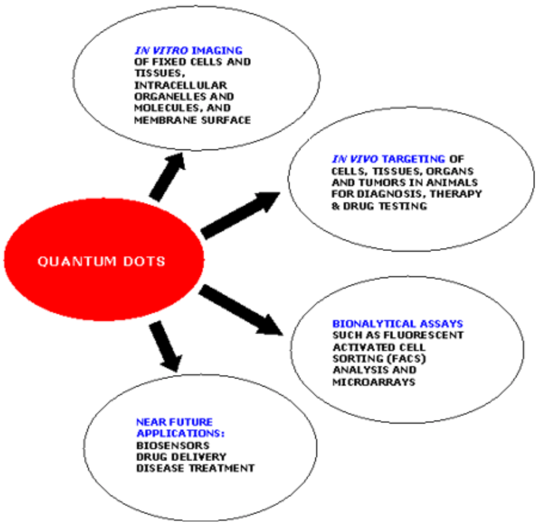
Fig. Applications in nanobiotechnology and microelectronics

Nanobiotechnology research in India

The emergence of nanotechnology in India has witnessed the engagement of a diverse set of players, each with their respective agenda and role. Nanotechnology promises to deliver novel products and processes or enhance the performance of existing ones across sectors. They include interventions in a range of domains like water, energy, health, agriculture and environment that could enable solutions to several development related problems especially in developing countries. Several industry related sectors like pharmaceuticals, electronics, automobiles, textile, chemicals and manufacturing sector, information technology and communications as well as biotechnology appear poised to gain from nanotechnology applications. The desire to harness this potential has prompted global interest in nanotechnologies.

DBT, (GoI) sanctioned nanobiotechnology projects to make use of these tools for larger action in all over India and the department has taken special initiatives advertisements inviting scientists across all disciplines to apply for grant. As a sequel, a number of R&D projects have been funded.

- **Nichi-In Center for Regenerative Medicine (NCRM)**, based in Chennai, India, is an Indo-Japan joint venture institute that carries out research, training and clinical applications protocol development in regenerative medicine, with emphasis on stem cells, progenitor cells and autologous adult cells with regenerative capability to take them to clinical application. India is still in its infancy. Though nanocoated anti-cancer drugs like Doxil have been in clinical application in the US. NCRM has been working closely with 240 different nanomaterials and technologies in specialties such as ophthalmology (corneal regeneration), orthopedics (cartilage injury repair), and hematology (expansion of hematopoietic stem cells).
- **University of Madras and Anna University**, Chennai is using 'quantum dots (QD)' as a fluorescent label to detect cancer cells in place of conventional methods. Results show that cellular toxicity of engineered QTC is minimal even at higher concentration and could be used as effective imaging tools for cancer cell imaging.



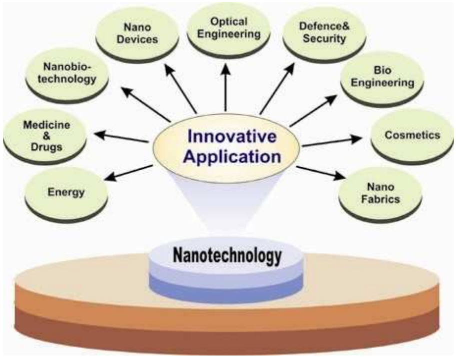
- **Periyar Maniammai University,** Thanjavur is working on immobilization of proteins over various substrates after suitable surface modification. The work has been extended to disease specific human antibodies (Hepatitis, PSA) and development of DNA methylation markers for breast cancer. Attempts have been made to construct nanostructures with DNA oligonucleotides based on cancer specific gene for their application in the targeted drug delivery.

- **NanoBiotech Laboratory, Dept of Zoology, Kirori Mal College, University of Delhi** have synthesized Gelatin, Type B NPs between 100nm-150nm by an improved two-step desolvation process. Anti-cancer drug Paclitaxel was encapsulated in biopolymeric NPs with ~25% entrapment efficiency. Drug-induced decrease in cell numbers was measured using MTT assay. It showed increased anti-tumour activity over a period of time. The characterization of the Gelatin-PEG NPs is in progress.
- **Nanomaterials Lab, IICT, Hyderabad** worked on the development of biocompatible polymer inorganic nano-composites as packaging materials to generate toxicological data of Nanomaterials(NMs) of medical importance. The acute oral and dermal toxicity test has been conducted.
- **IIT, Guwahati** has developed a novel and ‘green’ method of synthesizing Au NPs with extraordinary size specificity in aqueous medium using purified GFP expressed in *E. coli*. The fate of the protein during the synthesis of NPs was also investigated. Synergistic effect of Ag NPs as potential anti-cancer agent, when used in combination with uracil-phosphoribosyl transferase in suicide gene therapy models was studied. Encapsulated Ag NPs with biocompatible chitosan nano-vehicle in presence of iodine, analgesic drugs and other molecules are currently being studied for their effects on cellular DNA and proteins, microbes and cancer cells.
- **SCTIMST, Thiruvananthapuram** has synthesized and characterized a few novel polymers to develop innovative nano-structured polymer composite materials and to explore the interactions between the biological systems and nanostructures.
- **IICT, Mumbai** is aiming to develop the colloidal nanocarriers i.e solid lipid NPs, nanostructured lipid carriers, nano-emulsions and nanosuspensions for entrapping anti-malarial drugs such as Primaquine, Atovaquone and, Halofantrine; and assessing their therapeutic and immuno-modulatory potential. Feasibility studies on development of Nano-emulsion based drug delivery systems for Primaquine and Nanosuspension based systems for Atovaquone have also been completed.
- **University of Calcutta** has developed two model systems for assessing diagnostic and drug delivery potential of Au NPs. The use of NPs on platelets as a model system has been assessed.
- **IIT, Chennai** has planned to use QDs with modified guanine nucleotides for monitoring activation rates of G proteins. Recombinant G protein expression in bacteria have been optimized. Activity of the purified protein was checked in vitro.

Nanobiotechnology applications in future

In regenerative medicine, biological contamination-free in-vitro cell culture and tissue engineering are going to gain a great momentum with the help of nanomaterials and technology. The proven cell therapy applications such as corneal stem cell application, cell-based therapies in cosmetology, dental stem cell banking and applications will also show great promise.

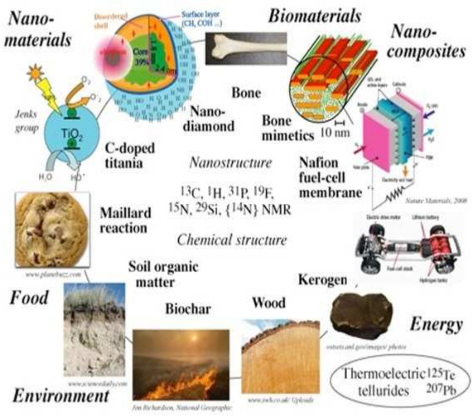
Hematopoietic stem cells (HSCs) are the cells that keep us alive by producing the RBCs, WBCs and platelets on a daily basis. These cells undergo damages with aging that are repaired by DNA ligase IV in-vivo. **NCRM** has been working on some biomimicking nano-environments for the cryopreservation and expansion of the HSCs so that when such environments (which include a micro-gravity and/or zero gravity environment in outer space) can prevent the process of aging, this will lead to the development of a novel anti-aging treatment in the future.



Nanotechnology in Environment

In environment protection, nano-science and engineering could significantly affect molecular understanding of nano-scale processes that take place in the environment; the generation and remediation of environmental problems through control of emissions; the development of new "green" technologies that minimize the production of undesirable by-products; and the remediation of existing waste sites and streams.

Nanotechnology offers new solutions through particles and filter systems that can bind and remove or inactivate pollutants within land, sea and air. The promise is of more efficient use of resources, renewable energy, environmental monitoring and many more benefits. Along with all these benefits, it is important to recognize that nanoparticles are a still relatively unknown area, and therefore their effects must be researched thoroughly as soon as possible.



1. Cleaning up

Industrialization brought many benefits but also pollution. Although action has been taken over the past few decades to limit new pollution, there still remains the problem of removing those pollutants already in the environment and cleaning up after accidental spills. Nanotechnology offers new solutions through particles and filter systems that can bind and remove or inactivate pollutants within land, sea and air.

- **Binding Pollutants**

The problem is that modern life produces pollution – whether from exhaust fumes, chemical plants or fertilizers in the soil. However, many 'natural' pollutants also exist. Many existing technologies fail to cope with these problems, however new nanomaterials can be manufactured which can bind to these pollutants and then be mopped up (like use a sponge to mop-up spilled water).

- **Breaking Down**

Environmental remediation can benefit from the use of nanotechnology. At the forefront of this is the use of titanium dioxide nanoparticles. These function as catalysts which assist in the breakdown of larger or more reactive molecules into smaller or less reactive ones. For example, nitrogen dioxide and volatile organic compounds in exhaust fumes can be degraded into more benign compounds such as nitrates, small carbon containing compounds and water; all of which are more easily absorbed into the environment. Examples of this can be already being found in commercial products: Pilkington Glass have coated the surfaces of their glass with titanium dioxide nanoparticles to break down dirt. The process is started by sunlight and is completed by rainwater, which washes the residue off the surface of the glass the process and catalyses the breakdown of dirt. The rain is then able to easily wash it off.

2. Reducing Impact

Monitoring and cleaning up existing pollution only deals with what is happening in the present. We also need to look at our long-term impacts on the environment. This includes ensuring that new pollution is minimized, and that our use of natural resources is sustainable.

Nanotechnology-enabled materials can also be used to more effectively reduce the release of pollutants from human activities.

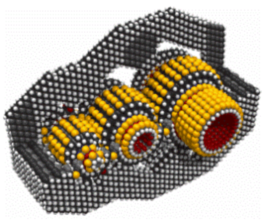
- **Lower Use of Material & Energy**

Nanotechnology offers two ways to reduce material and energy use.

(i) Nanomaterials are generally more active than bulk materials, and so either less material is required or the abilities of that material (e.g. insulation) are greatly enhanced.

(ii) More abundant materials can often be converted into excellent substitutes for rare materials through the application of nanotechnology (e.g. replacing platinum in catalytic convertors with nanostructured metal oxides).

These new applications can often be more energy efficient, both in manufacturing and in ultimate use. However, there needs to be a life cycle analysis approach to this to determine whether the new application is sustainable and whether it will actually reduce or increase the burden on the environment. This means determining the total material and energy use from product development through manufacture, use, and final recycling or disposal. For example, indium is used extensively in LCD screens and in new solar cell technologies. However it is only ever used in small amounts: a laptop screen for example contains 50mg of indium. Indium is only mined in 6 places around the world and at only 350tones each year; so it is clear that there is only a limited supply (e.g. compared to iron). 0There is obviously a real need to develop new nanomaterials that can take the place of materials such as indium, and that are more abundant. In the case of indium, nanostructured zinc oxide shows great promise, at least for certain applications.



- **Nano Filters**

Filters can benefit society and the environment in several ways. They can decrease pollution emitted from combustion, both in industrial processes and vehicles. They can also be used to remove pollution from drinking water. Nanovation are one of the main European companies producing nanotechnology-based filtration products. They can be used for drinking water purification, waste water treatment, as beverage filters and for the separation of oil and water. Nanomaterials are having an impact on filter technology, both passively and actively. Pore-sizes can be made small enough to block even the smallest virus particle. Filters can also incorporate activated materials such as titanium dioxide nanoparticles, which can help break down organic molecules, including those that make up bacteria and viruses.

3. Environmental Monitoring

It is widely recognized that modern society is having a large impact on the environment. As well as reducing this impact, there is an urgent need that we monitor the effects of human activity on the environment and how this alters with time, allowing us to take the most effective action.

While there are systems for monitoring, these tend to produce generalized data, and tell us little about changes in pollution as it happens. We can usually only see what damage we are doing when it is too late. Nanotechnology provides the means for quicker data, almost on the spot analysis, and enhanced sensor systems.

- **Nanoparticles**

Nanoparticles are all around us in nature, from nanoparticles of minerals in water to those in the air which come from fires and combustion. Most however are from human activities. Some 60% of nanoparticles in the environment are due to road transport, and a further 27% come from other combustion processes (such as power stations). It is the air-borne nanoparticles that are of most concern to human health, as it has been shown that increase in the levels of ultra-fine particulates in the air (which are less than 10 micrometer in diameter) can attribute to increased respiratory and cardiac disease, and there is increasing evidence that nanoparticles within this fraction can penetrate the lung causing inflammation and can spread to other organs within the body.

To take control of this situation we need two things:

(i) Reduce or prevent combustion nano-particle release:

Reduction can be achieved through the use of nanoporous filters for combustion processes. More recently the company Oxonica has manufactured a nanoparticulate of cerium oxide which increases the efficiency of diesel engines and decreases the amount of particulates they emit.

(ii) Provide effective monitoring in the environment:

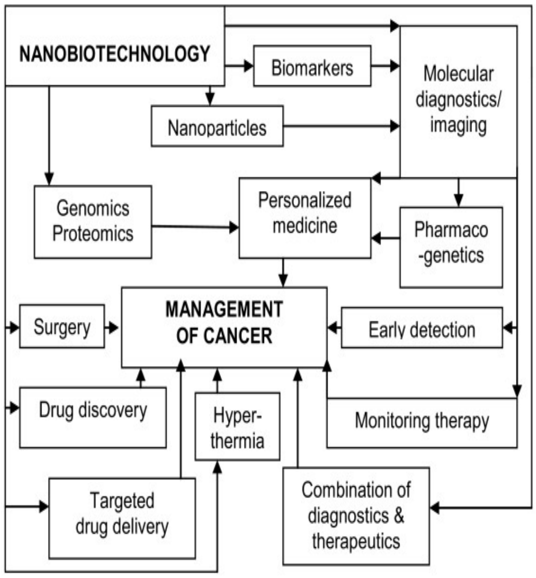
Monitoring can be achieved through a number of analytical methods that already exist and are being developed further by nanoscientists, which measure particle size, shape, surface area and chemical reactivity (all important aspects of a nanoparticle's activity

- **Localized Readings**

Existing technology uses large, fixed monitoring stations. Even in heavily-polluted areas, such as cities, these stations can be more than a kilometer apart. However, pollution can be extremely localised (e.g. traffic jams, industrial plants) and therefore it is important to pinpoint it. To do so requires a network of monitoring systems that can provide accurate localised readings in real time.

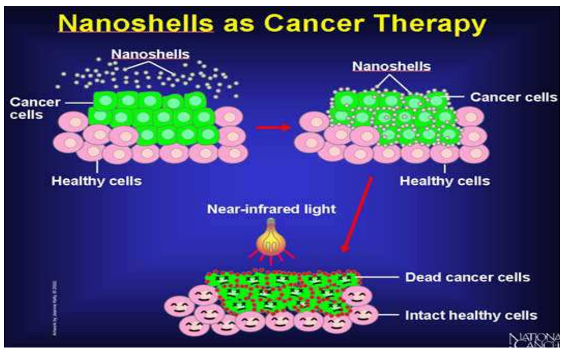
Thin films of nano-structured semiconductor materials such as tin oxide have been incorporated into small sensors about the size of a coin. These bind atmospheric pollutants such as carbon monoxide and nitrous oxides at levels below EU recommended guidelines, and release them again when the level of pollution drops (so the sensor is re-usable). The binding is detected electrically in real time and this information can be transmitted directly to a central computer for analysis.

Applications of Nanobiotechnology



❖ Cancer therapy

Photodynamic cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic. A greater quantity of a special dye that is used to generate the atomic oxygen is taken in by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed when exposed to a laser radiation. Unfortunately, the remaining dye molecules migrate to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks.



To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside a porous nanoparticle. The dye stayed trapped inside the Ormosil nanoparticle and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out.

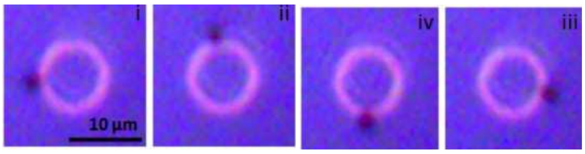
❖ Multicolour optical coding for biological assays

The ever increasing research in proteomics and genomic generates escalating number of sequence data and requires development of high throughput screening technologies. Realistically, various array technologies that are currently used in parallel analysis are likely to reach saturation when a number of array elements exceed several millions. A three-dimensional approach, based on optical "bar coding" of polymer particles in solution, is limited only by the number of unique tags one can reliably produce and detect.

Single quantum dots of compound semiconductors were successfully used as a replacement of organic dyes in various bio-tagging applications. This idea has been taken one step further by combining differently sized and hence having different fluorescent colours quantum dots, and combining them in polymeric microbeads. A precise control of quantum dot ratios has been achieved. The selection of nanoparticles used in those experiments had 6 different colours as well as 10 intensities. It is enough to encode over 1 million combinations. The uniformity and reproducibility of beads was high letting for the bead identification accuracies of 99.99%.

❖ Manipulation of cells and biomolecules

Functionalised magnetic nanoparticles have found many applications including cell separation and probing; these and other applications are discussed in a recent review. Most of the magnetic particles studied so far are spherical, which somewhat limits the possibilities to make these nanoparticles multifunctional. Alternative cylindrically shaped nanoparticles can be created by employing metal electrodeposition into nanoporous alumina template. Depending on the properties of the template, nanocylinder radius can be selected in the range of 5 to 500 nm while their length can be as big as 60 μm. By sequentially depositing various thicknesses of different metals, the structure and the magnetic properties of individual cylinders can be tuned widely.



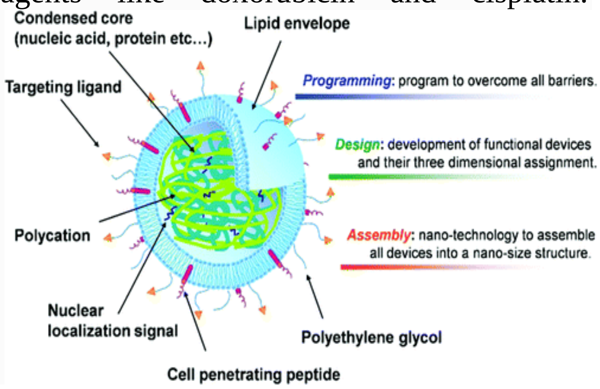
As surface chemistry for functionalisation of metal surfaces is well developed, different ligands can be selectively attached to different segments. For example, porphyrins with thiol or carboxyl linkers were simultaneously attached to the gold or nickel segments respectively. Thus, it is possible to produce magnetic nanowires with spatially segregated fluorescent parts. In addition, because of the large aspect ratios, the residual magnetisation of these nanowires can be high. Hence, weaker magnetic field can be used to drive them. It has been shown that a self-assembly of magnetic nanowires in suspension can be controlled by weak external magnetic fields. This would potentially allow controlling cell assembly in different shapes and forms. Moreover, an external magnetic field can be combined with a lithographically defined magnetic pattern ("magnetic trapping").

❖ Protein detection

Proteins are the important part of the cell's language, machinery and structure, and understanding their functionalities is extremely important for further progress in human well being. Gold nanoparticles are widely used in immunohistochemistry to identify protein-protein interaction. However, the multiple simultaneous detection capabilities of this technique are fairly limited. Surface-enhanced Raman scattering spectroscopy is a well-established technique for detection and identification of single dye molecules. By combining both methods in a single nanoparticle probe one can drastically improve the multiplexing capabilities of protein probes. The group of Prof. Mirkin has designed a sophisticated multifunctional probe that is built around a 13 nm gold nanoparticle. The nanoparticles are coated with hydrophilic oligonucleotides containing a Raman dye at one end and terminally capped with a small molecule recognition element (e.g. biotin). Moreover, this molecule is catalytically active and will be coated with silver in the solution of Ag (I) and hydroquinone. After the probe is attached to a small molecule or an antigen it is designed to detect, the substrate is exposed to silver and hydroquinone solution. A silver-plating is happening close to the Raman dye, which allows for dye signature detection with a standard Raman microscope. Apart from being able to recognise small molecules this probe can be modified to contain antibodies on the surface to recognise proteins. When tested in the protein array format against both small molecules and proteins, the probe has shown no cross-reactivity.

❖ Drug and gene delivery

Nanoparticles used as drug delivery vehicles are generally < 100 nm in at least one dimension, and consist of different biodegradable materials such as natural or synthetic polymers, lipids, or metals. Nanoparticles are taken up by cells more efficiently than larger micromolecules and therefore, could be used as effective transport and delivery systems. For therapeutic applications, drugs can either be integrated in the matrix of the particle or attached to the particle surface. A drug targeting system should be able to control the fate of a drug entering the biological environment. Nanosystems with different compositions and biological properties have been extensively investigated for drug and gene delivery applications. An effective approach for achieving efficient drug delivery would be to rationally develop nanosystems based on the understanding of their interactions with the biological environment, target cell population, target cell-surface receptors, changes in cell receptors that occur with progression of disease, mechanism and site of drug action, drug retention, multiple drug administration, molecular mechanisms, and pathobiology of the disease under consideration. It is also important to understand the barriers to drug such as stability of therapeutic agents in the living cell environment. Reduced drug efficacy could be due to instability of drug inside the cell, unavailability due to multiple targeting or chemical properties of delivering molecules, alterations in genetic makeup of cell-surface receptors, over-expression of efflux pumps, changes in signalling pathways with the progression of disease, or drug degradation. For instance, excessive DNA methylation with the progression of cancer causes failure of several anti-neoplastic agents like doxorubicin and cisplatin.



❖ Nano-DNA Technology

The discovery of the polymerase chain reaction (PCR) paved the way to a new era of biological research. The impact can be felt not only in the field of molecular biology, but also in other allied fields of science. Novel classes of semi-synthetic DNA-protein conjugates, self-assembled oligomeric networks consisting of streptavidin and double-stranded DNA, which can be converted into well-defined supramolecular nanocircles, have been developed.

The DNA-streptavidin conjugates are applicable as modular building blocks for the production of new immunological reagents for the ultrasensitive trace analysis of proteins and other antigens by means of immuno-PCR methodology. Immuno-PCR is a combination of the specificity of an antibody-based immuno-assay with the exponential power of the amplification of PCR, hence resulting in a 1000-fold degree of sensitivity as compared with standard

ELISA (Enzyme-linked immunosorbent assay) methods.

Self-assembled DNA-streptavidin conjugates have also been applied in the field of nanotechnology. For example, the conjugates are used as model systems for ion-switchable nanoparticle networks, as nanometre-scale 'soft material' calibration standards for scanning probe microscopy, or as programmed building blocks for the rational construction of complex bimolecular architecture, which may be used as templates for the growth of nanometre-scale inorganic devices. Covalent conjugates of single-stranded DNA and streptavidin are used as bimolecular adapters for the immobilization of biotinylated macromolecules at solid substrates through nucleic acid hybridization. This 'DNA-directed immobilization' allows for reversible and site-selective functionalization of solid substrates with metal and semiconductor nanoparticles or, vice versa, for the DNA directed functionalization of gold nanoparticles with proteins, such as immunoglobulin and enzymes. The fabrication of functional biometallic nanostructures from gold nanoparticles and antibodies are applied as diagnostic tools in bioanalytics.

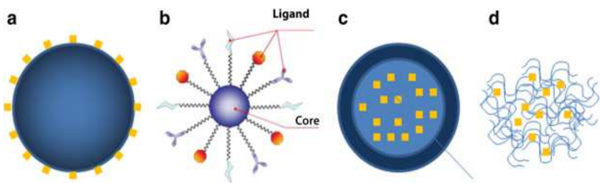


Fig. Schematic representation of different nanodevices for delivery of pesticides, fertilizers or nucleic acids (a) adsorption on nanoparticle; (b) attachment on nanoparticle mediated by different ligands; (c) encapsulation in nanoparticulate polymeric shell; (d) entrapment in polymeric nanoparticle.

❖ Nanoparticles as Biomarkers

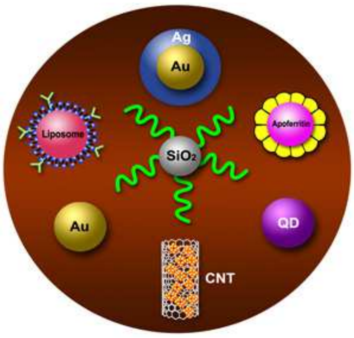
Nanoparticles can be used for both quantitative and qualitative in vitro detection of tumour cells. They enhance the detection process by concentrating and protecting a marker from degradation, in order to render the analysis more sensitive. For instance, streptavidin-coated fluorescent polystyrene nanospheres Fluospheres (green fluorescence) and Trans Fluospheres (red fluorescence) were applied in single colour flow cytometry to detect the epidermal growth factor receptor (EGFR) on A431 cells (human epidermoid carcinoma cells). The results have shown that the fluorescent nanospheres provided a sensitivity of 25 times more than that of the conjugate streptavidin-fluorescein.

New tools can now be developed, designed at the intersection of proteomics and nanotechnology, whereby nanoharvesting agents can be instilled into the circulation (e.g. derivatized gold particles) or into the blood collection devices to act as ″molecular mops″ that soak up and amplify the bound and complexed biomarkers that exist. These nanoparticles, with their bound diagnostic cargo, can be directly queried via mass spectrometry to reveal the low molecular weight and enriched biomarker signatures.

Contrast agents have been loaded onto nanoparticles for tumour diagnosis purposes. The physico-chemical features (particle size, surface charge, surface coating, and stability) of the nanoparticles allow the redirection and the concentration of the marker at the specific site of interest. Labelled colloidal particles could be used as radiodiagnostic agents. On the other hand, some non-labelled colloidal systems are already in use and some are still being tested as contrast agents in related diagnosis procedures such as computed tomography and NMR imaging.

The study of radionuclide use in diagnostic imaging with nanoparticles for cancer detection is yet to be published. However, as conventional colloidal particles can be cells of organs like the liver, the spleen, the lungs and the bone marrow and as long-circulating nanoparticles can have a compartmental localization in the blood circulation or the lymphatic system- all these organs being potential sites for tumour development, these colloidal systems could potentially improve tumour diagnosis.

In the future, nanoparticles that are engineered with specific binding affinities can be resuspended into the collected body fluids, or perhaps even injected directly into the circulation. The nanoparticles, together with the bound molecules, could be directly captured on engineered filters and directly questioned by ultra high-resolution mass spectrometry.



❖ Nanotechnology in Measurements of Dissolved Oxygen (DO)

Measurement of dissolved oxygen is of vital importance in medical, industrial, and environmental applications. Recent interest in the methods for measuring DO concentration has been focused mainly on optical sensors, due to their advantages over conventional amperometric electrodes in that they are faster, do not consume oxygen, and are not easily poisoned.

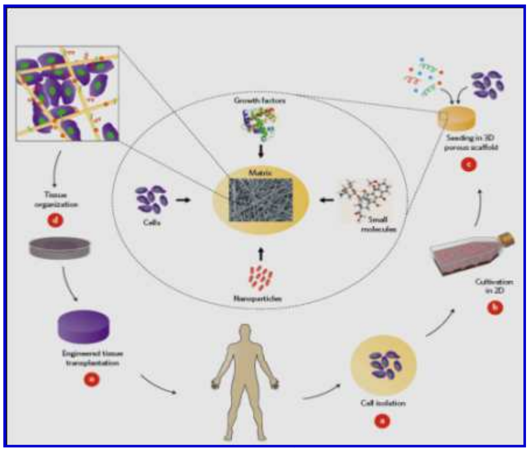
Optical PEBBLE (probes encapsulated by biologically localized embedding) nanosensors have been developed for DO using organically modified silicate (ormosil) nanoparticles as a matrix. The ormosil nanoparticles are prepared through a sol-gel-based process, which includes the formation of core particles with phenyltrimethoxysilane as a precursor followed by the formation of a coating layer with methyl trimethoxysilane as a precursor. The highly permeable structure and the hydrophobic nature of the ormosil nanoparticles, as well as their small size, result in an excellent overall quenching response to DO and a linear response over the whole range, from 0 -100% oxygen-saturated water. The PEBBLE sensors are excellent in terms of their reversibility and stability to leaching and long-term storage. A real-time monitoring of changes in the DO due to cell respiration in a closed chamber was made by gene gun delivered PEBBLE. This sensor is now being applied for simultaneous intracellular measurements of oxygen and glucose.

❖ Tissue engineering

Tissue engineering is based on the creation of new tissues in vitro followed by surgical placement in the body or the stimulation of normal repair in situ using bioartificial constructs or implants of living cells introduced in or near the area of damage. Though it is mainly concerned with using human material, either from the patient themselves (autologous) or from other human sources (allogeneic), material from other mammalian sources have also been applied in humans (xenogeneic).

The involvement of microelectronics or nanotechnology in creating a truly bioartificial tissue or organ that can take the place of one that is terminally diseased, such as an eye, ear, heart, or joint has been envisaged. Implantable prosthetic devices and nanoscaffolds for use in the growing of artificial organs are goals of nanotechnology researchers. Nanoengineering of hydroxyapatite for bone replacement is reasonably advanced.

In the future, we could imagine a world where medical nanodevices are routinely implanted or even injected into the bloodstream to monitor wellness and to automatically participate in the repair of systems that deviate from established norms. These nanobots could be personalized by tailoring them to patient genotype and phenotype to optimize intervention at the earliest stage in the course of disease expression.



❖ Growth of New Organs

Nanoscale building of cells can be accomplished by their programmed replication. The signals are transmitted back and forth with the instruction for the desired size and shape form the construction site. When complete instructions are finished, the organs can be grown according to the prerequisite specifications.

These organs could have the necessary DNA encoded to be compatible with the required human body immunological status. This can enhance integration of artificial structures with living tissues, presenting a more appropriate interface to biological systems. With the advantage in absence of immune reaction unlike today's donor organ transplantation. In the years to come this can accomplish a Quantum leap in the management of organ failure disorders.

❖ Nanomedicines

Nanomedicine is the process of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain, and of preserving and improving human health, using molecular tools and molecular knowledge of the human body. In the relatively near term, nanomedicine can address many important medical problems by using nanoscale-structured materials and simple nanodevices that can be manufactured today, including the interaction of nanostructured materials with biological systems. In the mid-term, biotechnology will make possible even more remarkable advances in molecular medicine and biorobotics, including microbiological biorobots or engineered organisms. In the longer term, perhaps 10–20 years from today, the earliest molecular machine systems and nanorobots may join the medical armamentarium, finally giving physicians the most potent tools imaginable toconquer human disease, ill-health, and aging.

Nanobiotechnology approaches are being actively investigated in the designing of functionalized biodegradable nanoparticulate drug delivery system (NPDDS) of Doxorubicin hydrochloride (DOX) using an asialoglycoprotein receptor (ASGPR). The work on the nanoparticle-aided delivery of bioactive molecules is in progress. Considerable efforts were made by various research groups including pharmaceutical companies in developing smarter non-viral vectors capable of delivering therapeutic agents safely, efficiently and in a specific manner..

❖ Nano-Pesticides

Amorphous or non crystalline silica naoparticle is non hazardous to human beings. ISI, Kolkata, developed a spherical, amorphous, silica nanoparticles based pesticide named as Dipentox. Due to the lipophilic nature of the product, Dipentox is also effective in highly humid conditions. Nanocides of this category are needed in small quantities when compared to the conventional pesticides. Moreover, they were found to be cost effective. Bioassay studies with various group of insects established their biosafety.

❖ Nano-Agriculture

In the agricultural sector, nanotech research and development is likely to facilitate and frame the next stage of development of genetically modified crops, animal production inputs, chemical pesticides and precision farming techniques. While nano-chemical pesticides are already in use, other applications are still in their early stages, and it may be many years before they are commercialized. These applications are largely intended to address some of the limitations and challenges facing large-scale, chemical and capital intensive farming systems. This includes the fine-tuning and more precise micro-management of soils; the more efficient and targeted use of inputs; new toxin formulations for pest control; new crop and animal traits; and the diversification and differentiation of farming practices and products within the context of large-scale and highly uniform systems of production.

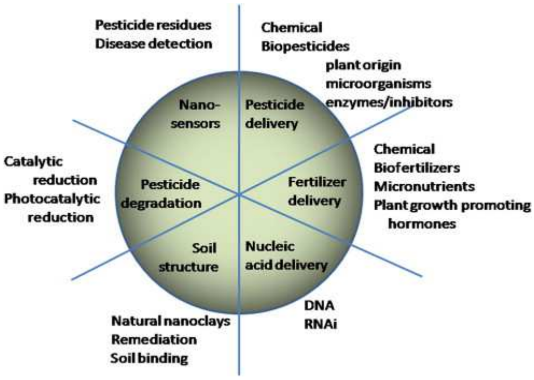


Fig. Applications of nano-biotechnology in plant protection and nutrition

Nanotechnology Challenges, Risks and Ethics

The most immediate challenge in nanotechnology is that we need to learn more about materials and their properties at the nanoscale. Universities and corporations across the world are rigorously studying how atoms fit together to form larger structures. We are still learning about how quantum mechanics impact substances at the nanoscale. Because elements at the nanoscale behave differently than they do in their bulk form, there is a concern that some nanoparticles could be toxic. Some doctors worry that the nanoparticles are so small, that they could easily cross the **blood-brain barrier**, a membrane that protects the brain from harmful chemicals in the bloodstream. If we plan on using nanoparticles to coat everything from our clothing to our highways, we need to be sure that they won't poison us.

Certain nanoparticles have been shown in animal studies to translocate along the olfactory nerve into the brain, cross the placenta and penetrate damaged or diseased skin. Once inside the body, certain nanoparticles have induced inflammatory responses, cardiovascular effects, pulmonary fibrosis and genotoxicity. It must be emphasized, however, that effects demonstrated by one type of nanoparticle in one laboratory study cannot be generalized to other nanoparticles.

Estimation of the potential health risks associated with these new materials requires understanding of the mechanisms of ill health, the identification of some property or metric of the material which relates exposure to the material to health risk and some method for measuring exposure in relation to that metric. Once these are in place, it is potentially possible to define safe levels of exposure to these materials and if needed to design control methodologies to enable exposures to be maintained at or below these safe levels. For nanoparticles, there is currently poor understanding of all of these issues.

Nanoparticles are encountered in ambient air as well as in the workplace, and in terms of particle number and surface, they totally dominate the ambient particle levels. Epidemiological studies have shown an association between increased particulate air pollution and adverse health in susceptible members of the population, in particular the elderly with respiratory and cardiovascular diseases. This association has been found to be particularly relevant for the finer fractions of the airborne particles (PM2.5 and PM1).

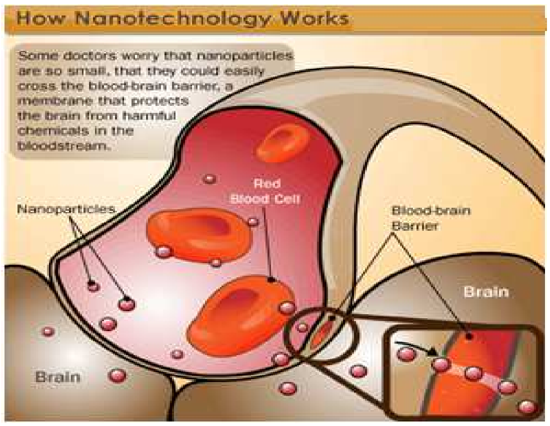


Fig. Risk assessment framework for nanomaterials.

Table: Indian Companies commercializing Nano products

Company	Products and Activities
Auto Fibre Craft	Nano-size Silver Powder for use in electronic applications for e.g. making conductive inks and pastes, RFID. This product is RoHS compliant.
Center for Advance Research & Development (CARD).	Nanotechnology based Nanoblaster technology - developed a new technique to blast cancer cells in the human brain and other parts of the human body. Rational field quantum magnetic resonance' (RFQMR) generator'-non-invasive technique to regenerate dying tissues in the body that cause serious disabilities in arthritis patients. Technique to detect cancer at early stage.
Dabur Research Foundation	Nanoxel, Development of Nano-polymer & Liposome based Drug Delivery Systems Formulation of Solid & Injectable Dosage forms for Cytotoxics. It is India's first indigenously developed nanotechnology based chemotherapy agent effective and safe therapy for advanced breast, non-small-cell lung, & ovarian carcinomas.
Icon Analytical Equipment	The company is a distributor of analytical instruments, with a focus on nanotechnology and related analytical techniques.
Micromaterials (India)	Developing innovative nano and micro technologies and materials catalysts.
Mittal Enterprises	Nanofluid Interferometer and other Laboratory and Scientific Instruments
Monad Nanotech; Mumbai	Produces carbon nano material (CNM) at commercial level via using plant based material for the production of different types of CNM.
Mp3s Nanotechnology	Equipment and chemicals based on nanotechnology. Its products include equipment for textile waste water recycling in dyeing and other process.
Nano Cutting Edge Technology Pvt Ltd - Nanocet,	Silver-Nano gel, Gold- Nano gel and Biostabilised Iron-Palladium nanoparticles. A variety of semiconductor and transition metal nanoparticles have been synthesized using a eco-friendly methods using metal interacting microorganisms.
NanoBio Chemicals	Producer of high quality nanoparticles using patented technology and also custom synthesis of complex peptides and biochemicals.
NanoFactor Materials Technologies	Synthesis of Carbon Nanotubes.
Nanoshel	Makes more than 50 types of nanomaterials, among which the main products are nanotubes, SWCNT´s, MWCNT´s, nanoparticles.
Navran Advanced Nanoproducts Development	The company develops and manufactures nanoproducts such as polymerized toners.
Nilima Nanotechnologies	Produce a wide range of nanotechnology based coatings with protective properties for various surfaces.
Qtech Nanosystems;	Expertise in nanomanipulation and nanopositioning technology
Quantum Corporation	High quality Smart Polymers, Nanomaterials & Nanocomposites as core materials for manufacturers in Telecommunications, Electronics, Drug Delivery, Conductive films, Lighting and Energy industries.
Quantum Materials Co.	Manufactures carbon nanotubes and graphene.
Redex Nano Labs	A manufacturer of advanced performance and specialty chemicals based on nanotechnology.
Reinste Nano Ventures	A manufacturer of nanomaterials.
Saint-Gobain Glass	Manufactures SGG NANO, a high performance coated glass with advanced energy efficient solar control & thermal insulation (low e) properties.
Sisco Research Laboratories	Nanopowders and Carbon Nanotubes
United Nanotechnologies	Manufactures nanoparticle-based coatings.
Velbionanotech, Bangalore	Bionanochip, nano medicine, nanomaterial, Microdoctor, nano-sensors & herbal medicine. Designing DNA based drug for heart disease, kidney stones, AIDS & Cancer.
Yash nanotech, Mumbai	Provides global nanotechnology business intelligence and consulting services to industries and investors worldwide Mission.

FORTHCOMING EVENTS

Events	Date	Place & Correspondence
Nano Suspensions India,2012	August 21, 2012	Hyderabad, India http://www.nanosuspensions-india.com
6th International Conference on Nanotoxicology (Nanotoxicology 2012)	September 4- 7, 2012	Beijing (PR China) http://english.nanoctr.cas.cn/nanotoxicology2012/
7th International Conference on the Environmental Effects of Nanoparticles and Nanomaterials	September 10-12, 2012	Banff, AB (Canada) http://www.oens.ualberta.ca/banff-2012-conference/
Trends in Nanotechnology International Conference (TNT2012)	September 10-14, 2012	Calle Alfonso Gomez 17 - Planta 2 - Loft16 28037 Madrid, Spain http://www.tntconf.org/2012/index.php?conf=12
3rd International Conference on Nano Science and Technology (ICNST 2012)	September 15- 16, 2012	Beijing (PR China) www.icnst.org
Nanotechnology Application in Energy and Environment (NAEE2012)	September 20 – 21, 2012	Institut Teknologi, Bandung, Indonesia http://portal.fi.itb.ac.id/naee2012
Fifth Annual Nanotechnology and Nanomedicine Symposium	September 21-22, 2012	2100 Gardiner Lane, Louisville, KY 40205, USA http://www.sullivan.edu/pharmacy/NANO-index.asp
Nanotechnology Conference 2012	October 31-Nov. 3, 2012	Riviera Maya, Mexico http://www.zingconferences.com/index.cfm?page=conference&intConferenceID=95&type=conference
National Conference on Nanomaterials	December 3-4, 2012	Karunya University, Karunya Nagar, Coimbatore - 641 114, Tamilnadu, http://www.karunya.edu/sh/physics/NCN-2012
2nd International Conference on Nanotek and Expo	December 3-5, 2012	Philadelphi, Pennsylvania, USA http://www.omicsonline.org/nanotek2012/

QUERY FORM

Name:
Designation:
Email:
Area of specialization:
Views on our Newsletter
Suggestion for Improvement:
I would like to collect information on Environmental Biotechnology on the following:
Subject: **Key words:**

FROM	To,
ENVIS CENTRE **DEPARTMENT OF ENVIRONMENTAL SCIENCE UNIVERSITY OF KALYANI, KALYANI-741235, NADIA, WEST BENGAL**	**BOOK POST** __________ __________ __________