

Bio-nanotechnology: muse for scientists and engineers

The next step in the miniaturization path that provided us microchips, microcircuits and microelectronics is nanotechnology, which is one-thousandth of a micrometre (approximately the size of a molecule). The essence of nanotechnology is the ability to work at the molecular level, atom by atom, to create large structures or devices with vitally new molecular organization. Bio-nanotechnology is a branch of nanotechnology that uses biological materials, biological principles or applications. It deals with the study and creation or manufacture of ultra-small structures which are made up of as little as one molecule. Nanotechnology will surely improve the state of the developing world, and as a newly emerging technology of the 21st century, it has the potential to solve the most vital problems of the world community¹. Bio-nanotechnology takes help from molecular biologists to understand the nanostructure and nanomachines designed by nature's four billion years of engineering. Bio-nanotechnology accomplishes many goals that are impossible to achieve by other means like, for example, the DNA which is a biological information storage molecule, which may serve as a basis for the next-generation computer chips, thereby converting microprocessors and microcircuits to nanoprocessors and nanocircuits. The structure of the DNA is being utilized for 2D and 3D constructions like DNA-based shape shifting structures to gears and walkers². Forthcoming applications of bio-nanotechnology include creation of bio-nanostructures, miniaturizing biosensors, increasing the speed of disease diagnostics and improving the specificity and timing of drug delivery. There is increasing sanguinity that nanotechnology applied to medicine will bring significant development in the diagnosis and treatment of cancer³. Highly innovative approaches of this technology also offer

promises for early detection and diagnosis, these are nanostructured surfaces for proteomics, the bio-bar code method for the amplification of protein signatures via the use of two-particle (sandwich assay), nanowires as biologically gated transistors, transducer molecular-binding events into real-time electrical signals and silicon cantilevers for the mechanics-based recognition of biomolecular populations⁴.

Advocating nanotechnology, our President A. P. J. Abdul Kalam has urged scientists and industrialists to combine forces to bring world-class nano-products in the world market. According to Kalam, 'we missed the revolution in micro-electronics in the seventies'. He also said that 'we should grab the opportunities in nanotechnology now'. According to Kalam⁵, scientists from India have already invented nano-products like carbon nanotube water filters, typhoid detection kit and drug delivery system.

Future applications of this technology include development of *in vivo* sensors. Nano-sized devices are foreseen to be injected into the body where they act as reporters and transmit data to an external data-capturing system. Nano-objects which have important analytical applications include nanotubes, nanochannels, nanoparticles, nanopores, nanocapacitors, nanocantilevers, quantum dots, nanorods and nanoprisms. To automate molecular manufacturing, engineering of molecular products needs to be carried out by robotic devices, which have been termed as nanorobots. The nanorobot is a handy machine at the nanometre or molecular scale that is composed of nanoscale components⁶. These materials will enhance the ability to develop more sensitive analytical systems and future diagnostics⁷. To eliminate death and suffering from cancer by 2015, the National Cancer Institute, USA is engaged in efforts to harness the

power of nanotechnology to completely change the way of diagnosis and treatment of cancer⁸. US President Bush's 2006 budget provides over \$1 billion for the multi-agency National Nanotechnology Initiative (NNI), bringing the total NNI investment under this administration to \$4.7 billion⁹. This indicates that the technology is not a fad. We are not sure that there is great positivism among researchers, politicians and policy makers who expect job creation with this technology. We believe that bio-nanotechnology will provide opportunities for developing countries to meet critical sustainable development challenges.

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