# Nanotechnology: Enabling a Revolution in Nanomedicine

Fifty years after US physicist and Nobel Laureate Richard Feynman predicted "There is plenty of room at the bottom", nanotechnology, the science of matter on the scale of atoms, has arrived with a bang and is beginning to impact all aspects of our society and all industrial sectors (for reference 1nm=1 billionth of a metre; a piece of paper is 100,000 nanometres thick).

The ability to see, manipulate and control materials, devices and systems with nanometer dimensions is creating new products for our homes, new electronics for our work and play, stronger and more durable metals and composites for industry and revolutionary new approaches to health care, diagnostics and therapy.

In nanomedicine, for example, the application of nanotechnology exploits the improved and often novel, physical, chemical and biological properties of materials at the nanoscale to address clinical needs in significant diseases and achieve breakthrough in healthcare. Nanotechnology is enabling the miniaturization of existing devices and tools to enable early detection and diagnosis.

Smaller, faster, cheaper are the key goals here. By integrating quantum dot barcode (QdotB) nanotechnologies with state-of-the-art, electro-kinetically driven micro-fluidics and fluorescence detection it is possible to develop hand-held lab-on-a-chip devices which provide a high throughput, multiplexed

analytical tool for rapid screening of infectious diseases. Such lab-on-a-chip devices represent a sea-change in simplicity, speed and cost for diagnosis. They have the potential to rapidly detect and identify serum biomarkers for pathogens of several dangerous infectious diseases in a single sample, eliminating multiple sampling and repeat visits to the clinic. Such systems may eventually completely replace existing non-portable and expensive bench-top analytical instruments. On-chip laboratory approaches are equally adaptable to the identification of toxins in environmental samples.

Another advance in nanomedicine is the development of smart nanoparticles for the targeted delivery of therapeutic agents. For a drug molecule to be effective in treating a disease it must be able to reach the sick organ or lesion. Tailored nanoparticles offer major advantages: minute size and high surface area/mass to facilitate transport and delivery; designed with a biodegradable polymer shell to encapsulate a drug in the core; with a "stealth" outer coating of polymer to prevent recognition of the drug by the immune system; and a set of peripheral "ligands" to recognize the target cell receptors. The nanoparticle is taken up by the cell, it attaches to the cancer or lesion and the biodegradable polymer releases the drug at the site. This is an approach to the delivery of therapeutic agents which shows great promise for improving disease treatment and is expected to be a significant growth area in the marketplace for new therapies in the next decade.

## About the Author

Dr. Arthur Carty is the board member of the Corporate Advisory Board at Bilcare Global Clinical Supplies (GCS). He provides technology and biotech expertise to Bilcare GCS.

Dr. Carty was the first Executive Director of the Waterloo Institute of Nanotechnology and former National Science Advisor to Canada's Prime Minister. He had a renowned career as the President of the National Research Council of Canada after which he was appointed as the National Science Advisor. He has spent 27 years as a professor of chemistry at the University of Waterloo, serving as the Chairman of the chemistry department and Dean of Research.

Dr. Carty has authored more than 285 papers in referred journals and multiple book chapters and review articles, and also has five patents to his credit. He serves as a member on multiple boards including two for the Networks of Centers of Excellence and Genome Canada. Dr. Carty is both an Officer of the Order of Canada and Officer de L'Ordre National du Merite of France. He holds a Ph.D. in Inorganic Chemistry from the University of Nottingham.