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.