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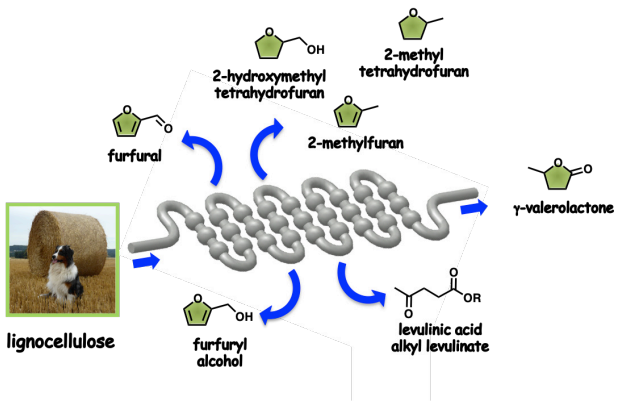
# "Greener" biocatalytic synthesis of novel polymeric nanomaterials: Applications in health and industrial sectors

**Virinder S Parmar**[1,2]
[1]University of Delhi, India
[2] The City University of New York, USA

We have developed a chemo-enzymatic synthesis for obtaining novel amphiphilic polymeric nanoparticles based on PEG having a broad range of additional chemical functionalities under mild "greener" conditions. Simplicity and versatility of this method for the synthesis of highly functionalized amphiphilic polymeric nanoparticles with the advantage of "green appeal" further enhance its applications as an important strategy. These unique alternating copolymer micellar nanoparticles have been used successfully for the encapsulation of a large number of drugs of different classes and delivery vehicles targeted to human cancer cells expressing the underglycosylated mucin-1 antigen, which is found on almost all epithelial cell adenocarcinomas. The solubility of the chemotherapy drug doxorubicin increased by encapsulation in these nanoparticles, and cellular uptake, and




hence cancerous cell death, was enhanced as compared to that with the free drug. The encapsulated taxol and doxorubicin showed significant enhanced activity against neuroblastoma cancer cells than anti-cancer drugs alone, and doxorubicin encapsulation showed three to six times better activity against pancreatic cancer cells. Nanospheres with different linker molecules such as naturally occurring aspartic acid and glutamic acid have also been prepared to assure non-toxic character of these nanomaterials and their biodegradability. The surface of these nanospheres is non-immunogenic as they are rich in PEG chains which do not interact with proteins. These polymers self-assemble in water to produce nanospheres with a typical diameter of 10-70 nanometers. Critical micelle concentration for these

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micelles is low (~0.25 millimolar). These materials are non-toxic; 60 g material per kg body weight can be tolerated. A novel nanotechnology platform for in vivo imaging and delivery of multifunctional therapeutics of cancer has also been designed based on perfluorinated amphiphilic copolymers. These nanoprobes are highly unique because of their ability to image and treat the cancer tumors by delivering the drugs to the cancer tumor sites.

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The methodology developed for the synthesis of perfluorinated copolymers is highly flexible and efficient. The *in vitro* and *in vivo* studies on these nanoprobes are in progress. Recently we have synthesized cationic polymers that constitute of guanidine functional groups and poly (ethylene glycol) units. Because of their strong basic character, guanidines are fully protonated under physiological conditions. The positive charge thus imposed on the molecule forms the basis for specific interactions between ligand and receptor or enzyme and substrate, i.e. as ammonium cations, they may bind to polyanionic DNA's and also to negatively charged cell surfaces to trigger endocytosis. Thus they may serve as gene siRNA delivery vehicles in order to cure many hereditary diseases and treat acquired diseases resulting from either multigenic disorders or foreign viral genes. The bio-derived non-crystallizable polymeric materials were used in formulating quasi-solid electrolyte compositions and incorporated into flexible dye-sensitized titanium oxide solar cells (DSSC). It was observed that the solar conversion efficiency of quasi-solid electrolytes incorporated solar cells depends strongly on the polymer microstructure used in formulating the redox electrolyte and our polymeric materials showed photovoltaic efficiency of up to 9%. Further, highly useful novel, non-toxic "environment-friendly" non-halogenated flame retardant organo-silicone polymeric materials using the above environmentally benign "green" biocatalytic technologies have been developed. These show superior properties than commercial flame retardant materials. These results shall be presented in the talk.

## Biography

Virinder S Parmar has completed his BSc Honors, MSc and PhD from the University of Delhi (India), and has worked for nearly 10 years as a Post-doctoral/Visiting Scientist at Cornell University, Harvard University, University of Massachusetts Lowell (UML), NYU-Poly and MIT (USA); the University of Basel (Switzerland) and the Imperial College of Science, Technology and Medicine (London, UK). He is currently a Faculty member in the Department of Chemistry and Environmental Science at Medgar Evers College, The City University of New York (Brooklyn, New York, USA). He has been a Faculty at St. Stephen's College and the University of Delhi (India) for 44 years, he was recently retired as Full Professor of Chemistry and has served as Head of the Department of Chemistry and as Chairman of the Board of Research Studies, and Provost of Gwyer Hall at this University. He has been an awardee of Medals for Excellence in Research from the Chemical Research Society of India (CRSI, Bangalore) for the year 2001 and of the Indian Society of Chemists and Biologists (ISCB, Lucknow) for the year 2009. He has been a recipient of the Academic Staff Award from the EXPERTS II Consortium of the European Union (EU) in December 2012 and April 2013. His research interests include: Green/Sustainable Chemistry, Nanotechnology, Organic Synthesis, Nucleic Acid Chemistry, Advanced Materials, Medicinal Chemistry, Biocatalysis and the Chemistry of Natural Products. He has delivered invited/plenary lectures at 147 international meetings and has given 398 research seminars at 293 Institutions in 31 countries across the globe. He is the Executive Editor of the Journal Biocatalysis and Biotransformation, and has been on the Editorial Boards of the Journals: ChemSusChem, Mendeleev Communications, Indian Journal of Chemistry, Natural Product Communications, Arkivoc, Molecules and ISRN Medicinal Chemistry.

vparmar@mec.cuny.edu