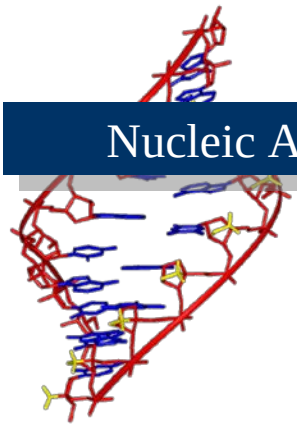

University of Southern Denmark

Nucleic Acid Center **Seminar** no. 72

Tuesday 5 April 2016
at 14:00 in the FKF Colloquium-room

Professor Virinder S. Parmar

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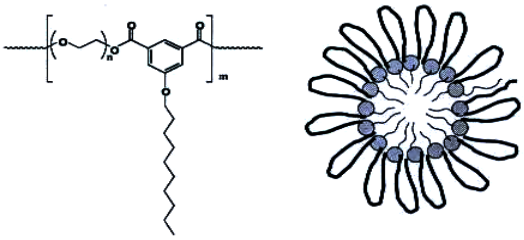
"*Biocatalytic Synthesis of Novel Polymeric Nanomaterials: Applications in Health and Industrial Sectors*"

Abstract:

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 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 3-6 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 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 thererapeutics 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. 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 strongly 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.

Based on lipase (*Candida antarctica* lipase B), oxidase (horse radish peroxidase) and their combination, the synthesis of pegylated polyelectrolytes has been developed. The pegylated macromers were polymerized and co-polymerized with various monomers of interest to generate a variety of tethered ion-conducting polymers for preparing quasi-solid electrolytes. 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.

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