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Unique structure and property of dendrimers in biomedical applications

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INTRODUCTION

Unique structure and property of dendrimers in biomedical applications

Dendrimers are the few types of synthetic polymers that can be precisely controlled in size and structure. The well-defined structure renders dendritic macromolecules unique properties for versatile applications, especially in the biomedical field. For example, phosphorus-containing dendrimers have shown anti-prion activity and can potentially be used as mediators for gene therapy (Solassol *et al.* 2004); Boronated starburst PAMAM (i.e. polyamidoamine) dendrimer-monoclonal antibody immunoconjugates have been used as potentially efficient anti-cancer reagents involving boron capture of neutron (Barth *et al.* 1994); Commercially available dendrimers such as PAMAM and PPI (polypropyleneimine) dendrimer have also been employed as magnetic resonance imaging contrast agents potentially to improve the quality of the clinical diagnostics (Kobayashi *et al.* 2003). Unlike the classic polymers, dendrimers are rather monodispersed (polydispersity close to 1.00), which makes them very similar to biomacromolecules such as proteins. They can be synthetically designed to mimic various biological functions of metalloproteins and enzymes such as supramolecular self-assembly, molecular recognition and complexation, etc. (Thayumanavan *et al.* 2003). Because of their unique cascade architecture, dendrimers can coordinate with metal ions selectively on different structural locations such as the surface, core, or branching focal point. This distinct feature has attracted great attention among scientists in many disciplines including organic, inorganic, organometallic, polymer, physical and biochemistry as well as materials science. Unique magnetic, electronic and optical properties have been intensively explored in dendritic materials. Dendrimer research has indeed become an interdisciplinary topic with a great influence on wide fields of science and technology. This special dendrimer focus issue of *Proceedings of the Royal Society A* intends to highlight the most recent progress in the synthesis, properties and applications of dendrimers and to gather the innovative ideas among scientists involved in the dendrimer field, particularly those related to chemical and biomedical research. Therefore, we have invited the leading scientists in these fields to contribute their recent findings and developments of dendrimeric materials. Each article intends to present the multiple aspects and orientations that can potentially satisfy the multidisciplinary interests of our readers. This dendrimer focus issue contains six papers that have undergone a thorough peer-review process and cover the following wide range of topics: an overview on eight-year pursuit of the development of triazine-based dendrimers

One contribution of 7 to a Special feature 'Current research trends in dendritic materials'.

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for potential therapeutic applications including infectious disease and cancer by E. E. Simanek (Texas A&M University; Simanek *et al.* 2010); an intramolecular 'sergeants and soldiers' experiment on amplification of local chirality within a folded dendrimer to mimic allostery in proteins by J. R. Parquette (the Ohio State University; Hofacker & Parquette 2010); a spectroscopic study on metal ion complexation of dense-shell glycodendrimers using UV/vis and electron paramagnetic resonance for understanding the function of metal proteins in processes such as copper metabolism by D. Appelhans (Leibniz Institute of Polymer Research Dresden; Appelhans *et al.* 2010); a novel organoplatinum antitumor prodrug based on the fourth generation PAMAM dendrimer for potential control-release of active platinum species in cancer treatment by B. Howell (Central Michigan University; Howell & Fan 2010); an investigation on haemotoxicity of PAMAM dendrimers and the protective role of human serum albumin in haemolysis by B. Klajnert (University of Lodz; Klajnert *et al.* 2010); and a pre-clinical and behavioural toxicity profile of PAMAM dendrimers in mice by A. S. Chauhan (Dendritic NanoTechnologies Inc.; Chauhan *et al.* 2010). These research endeavours demonstrate control of molecular properties for a variety of biomedical applications in the design of unique dendrimer structures via organic, inorganic, organometallic and biochemistry. Such a task needs the collaborative efforts of synthetic chemists, material engineers and molecular biologists as well as industry experts. Therefore, it is necessary for our society to promote interdisciplinary research, as exemplified in this special dendrimer focus issue.

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