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Porphyrin Supramolecular Assembly: Novel Structures and Functions

Porphyrins are aromatic, organic, light-absorbing molecules that occur abundantly in nature, especially in the form of molecular self-assemblies. In 2011, we first discovered 'porphysomes', the self-assembled porphyrin-lipid nanoparticles with intrinsic multimodal photonic properties. The high-density porphyrin packing in bilayers enables the absorption and conversion of light energy to heat with extremely high efficiency, making them ideal candidates for photothermal therapy and photoacoustic imaging. Upon nanostructure dissociation, fluorescence and photodynamic activity of porphyrin monomers are restored. In addition, metal ions can be directly incorporated into the porphyrin building blocks of the preformed porphysomes thus unlocking their potential for positron emission tomography and magnetic resonance imaigng. By changing the way porphyrin-lipid assembles, we developed lipoprotein-mimicking porphyrin nanoparticles, porphyrin microbubbles, giant porphyrin vesicle, hybrid porphyrin-metal nanoparticles and metal chelating texaphyrin nanoparticles. By mimicking the light harvesting systems found in photosynthetic bacteria, we have created supramolecular assemblies of highly ordered porphyrin aggregates possessing stimuli-responsive photonic properties. Such optical properties are also responsible for our discovery of the ultrasound-induced microbubbles-to-nanoparticle conversion phenomenon. In summary, the simple yet intrinsic multimodal nature of porphyrin nanoparticles represents a new nanomedicine paradigm and also confers its high clinical translation potential.

Dr. Gang Zheng completed his Postdoctoral training at the Roswell Park Cancer Institute following his Ph.D. at the State University of New York at Buffalo. In 2006, he joined the Princess Margaret Cancer Centre to continue research on cancer nanomedicine, molecular imaging and phototherapy,
but with main focus on developing clinically translatable technology platform to combat cancer. His lab develops new platform technologies to more effectively diagnose and treat cancer. They primiarily develop molecular imaging and phototherapy agents as well as nature-inspired theranostic nanomedicines, with a focus on creating clinically translatable technologies. His group discovered porphysome nanotechnology that opened a new frontier in cancer imaging and therapy and was named one of the "top 10 cancer breakthroughs of 2011" by the Canadian Cancer Society.