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Cubosomes for the Delivery of Biopharmaceuticals

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Biopharmaceuticals, including therapeutic proteins and peptides, represent the fastest growing class of new pharmaceuticals with application as treatments for auto-immune disorders, cancer and cardiovascular disease. Significant efforts have converged towards the design and development of more sophisticated delivery systems for protein-based pharmaceuticals, able to ensure controlled release of these bioactive compounds as well as protect the encapsulated therapeutic from denaturing processes such as enzymatic or acidic hydrolysis. Lipid-based nanomaterials are particularly useful for the encapsulation of amphiphilic proteins and peptides, as their bilayer structure mimics the native cell membrane environment and may assist in retaining the protein in a functionally active form.1 The research presented aims to elucidate the fundamental physicochemical interactions between lipidic nanomaterials, encapsulated proteins and peptides, and cells. In order to screen the large compositional space associated with the design of such materials, we focus on high-throughput methodologies, and the use of large national and international synchrotron facilities such as the Australian Synchrotron, the Bragg Institute and ASTRID2 synchrotron, Denmark. Uptake of cubosomes into eukaryotic cells was shown to be driven by a process of membrane fusion between the lipid bilayer that makes up the nanoparticle and the external cell membrane.2 Synchrotron CD experiments demonstrated that the lipidic cubic phase was able to protect encapsulated insulin against enzymatic degradation by chymotrypsin, which is typically found in the small intestine, over a period of several hours. Finally, the use of lipid nanoparticles as effective delivery vehicles for anti-microbial compounds will be discussed.3

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