An Artificial β-Cell in a Nanoparticle: Glucose-Responsive Insulin Delivery for Type 1 Diabetes

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The clinical challenge of type 1 diabetes is the inability to match circulating insulin to the prevailing blood glucose concentration in real time. Injected insulin cannot synchronise with plasma glucose and the resulting mismatch drives recurrent episodes of hyper- and hypoglycaemia. Hypoglycaemia is the more immediately dangerous: untreated, it progresses rapidly from confusion to impaired consciousness and coma. A therapy that lowered glucose without the risk of hypoglycaemia would transform diabetes management, freeing patients from the daily fear of collapse while reducing the long-term complications that drive the disease's morbidity.

Glucose-responsive, insulin-loaded nanoparticles can function as the β-cell does: sensing glucose and releasing insulin in proportion to it. We have engineered biodegradable, charge-switchable nanoparticles that achieve rapid and sustained glucose-responsive insulin release after a single subcutaneous injection, maintaining normoglycaemia in two distinct type 1 diabetic mouse models. This presentation will highlight our work within global efforts towards a "smart insulin," outline the design principles that govern responsiveness and biocompatibility and report on our progress toward an artificial β-cell.