Cell uptake of one-dimensional nanomaterials

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ABSTRACT

Understanding cell interaction with one-dimensional nanomaterials, including nanotubes, nanowires, nanofibers, filamentous bacteria, and certain nanoparticle chains, has fundamental importance to many applications such as biomedical diagnostics, therapeutics, and nanotoxicity. Here, we show that cell uptake of one-dimensional nanomaterials via receptor-mediated endocytosis is dominated by a single dimensionless parameter that scales with the membrane tension and radius of the nanomaterial and inversely with the membrane bending stiffness. It is shown that as cell membrane internalizes one-dimensional nanomaterials, the uptake follows a near-perpendicular entry mode at small membrane tension but it switches to a near-parallel interaction mode at large membrane tension.