A surprising system : polymeric nanoreactors containing a mimic with dual-enzyme activity

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Reactive oxygen species have been implicated in various diseases, but attempts to find efficient antioxidant treatments for such conditions have met with only limited success. Here, we have developed an antioxidant nanoreactor by encapsulating a dual-enzyme mimic of superoxide dismutase and catalase, in polymeric nanovesicles and examined how this nanoreactor combats oxidative stress. The mimic (CuIIENZm) is encapsulated inside poly-(2-methyloxazoline)–poly-(dimethylsiloxane)–poly(2-methyloxazoline) polymer vesicles that feature membranes permeable to superoxide, enabling the enzyme mimic to act in situ. We ensured that the size and shape of polymeric vesicles were not changed during the encapsulation procedure by analysis with light scattering and transmission electron microscopy, and that the structural geometry of CuIIENZm was preserved, as demonstrated by electron paramagnetic resonance and UV-vis spectroscopy. Due to its bi-functionality, CuIIENZm detoxified both superoxide radicals and related H2O2. The intracellular localization of the nanoreactor in THP-1 cells was established using confocal laser scanning microscopy and flow cytometry. No evident toxicity was found using MTS and LDH assays. As CuIIENZm remained active inside the vesicles therefore, these CuIIENZm-containing nanoreactors exhibited efficient antioxidant activity in THP-1 cells. Development of this simple, robust antioxidant nanoreactor represents a new direction in efficiently fighting oxidative stress.
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