Surface Coating of an Algal Cell with Elongated DNA Strands to Control the Loading and Releasing of Cationic Materials

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【Introduction】Cell engineering has been utilized to alter cellular functions. However, it is still challenging to significantly enhance them by gene manipulation. Conversely, modifying natural cells with artificial materials can strikingly extend cellular functions. To produce the "functionalized cell", it is supportive to form a polymer layer on the cell surface that mediates adhesion between cells and functional materials in physiological conditions. DNA is a suitable polymer as it is biocompatible and can be extended even under cell culture conditions with enzymatic reactions. Furthermore, negatively charged phosphate groups of DNA can function as a scaffold for loading cationic materials. In this study, as a model cell for functionalization, a unicellular alga, Chlamydomonas reinhardtii (CR), was modified with a DNA primer. The immobilized DNA primers were then elongated with a DNA polymerase to cover the CR cells with long DNA chains. A cationic gold nanoparticle was loaded onto the DNA layer through electrostatic interaction and released via degradation with an endonuclease to demonstrate endowment and deprivation of the function.

【Results and Discussion】

A DNA primer (X-motif) was conjugated with an oligopeptide of 4-hydroxyproline (HYP_{10}) that binds tightly to the CR cell wall[1] and immobilizes onto CR cell surface. By adding a DNA polymerase, Klenow fragment exo (-) (KF^-),[2] long double-stranded DNA chains with repeating sequences were elongated via slippage mechanisum[2] to form a thick DNA layer on the cell surface (Figure 1). A gold nanorod (GNR) coated with a cationic ligand (11-MTAB) was further modified onto the surface of the elongated DNA-coated cells through electrostatic interaction. Moreover, the release of modified GNRs was demonstrated by adding an endonuclease, DNase I, which degrades double- and single-stranded DNA (Figure 2).

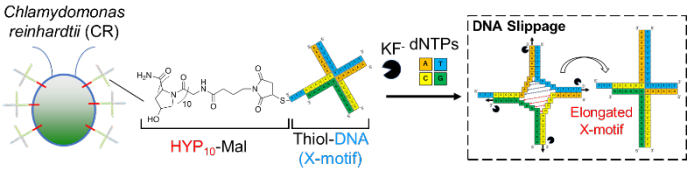

Figure 1. Elongation of DNA primers (X-motif) immobilized on CR cell surface with a DNA polymerase (KF-).

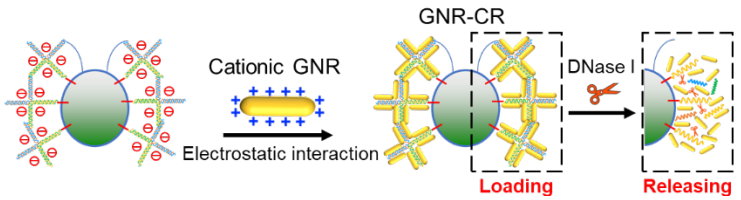

Figure 2. Cationic GNRs were loaded on CR cell surface through electrostatic interaction and released with an endonuclease (DNase I).

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