Regulating Electron Flow Using Fragmented Proteins

Published date: April 10, 2018

Technology description

This technology enhances control over the function of the protein electron carrier, Ferredoxin, via fragmentation and fusion to proteins that assist with fragment complementation upon chemical binding.

Challenge

Electron flow is an important consideration when engineering metabolism for the microbial production of high value chemicals (fuels, alcohols, saturated hydrocarbons, chiral bioactive molecules, and pharmaceutical compounds), because the amount and timing of electrons transferred between different donor and acceptor proteins determine the ratio of biomass accumulation versus chemical production. However, the accumulation of reduced and oxidized cofactors in genetically-engineered microbes can result in global redox imbalances that limit chemical production. Moreover, current approaches to solve the redox imbalance are limited to regulating transcription of protein electron carriers via the “on/off” molecular switch controlled by the promoter.

Solution

Ferredoxin is one of the most intensively studies families of protein electron carriers important for transferring electrons from a wide range of donor proteins to a diverse range of acceptor proteins. This technology enhances control over the function of the protein electron carrier, Ferredoxin, via fragmentation and fusion to proteins that assist with fragment complementation upon chemical binding. The design of this technology can be used to improve the control over electron flow into and out of cells for the production of chemicals and biosensing applications, such as those found in bioelectronics.

Technology Relevant Papers and Web Links

Atkinson, J. T., Campbell, I. Bennett, G. N., & Silberg, J. J. Cellular assays for ferredoxins: A strategy for understanding electron flow through protein carriers that link metabolic pathways.Biochemistry, 55(51) 2016: 7047-7064

Application area

This technology has several designs that introduced multiple new protein electron carriers who' s activities can be switched on and off by either multiple transcriptional inputs, a post-translational input, or combinations of these two mechanisms. This technology can be used during late-stage fermentation when cells are no longer actively growing and have more limited capacity for transcription.

Advantages

Energy conserving metabolic pathways for "green chemical production"
Provides increased transcriptional control over electron flow in cells using protein electron carriers, which allows for regulation of activity using combinations of natural promoters
Cells can be engineered with protein electron carriers to conserve energy by directing electron flow to desired partner proteins under desired conditions
Increased control over electron flow in cells can be used to improve the production of synthesized products

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