Engineered E. coli for Environmental Detection and Degradation of PFAS via a Dual-Fluorescence System

Wang, Siwei (School: Beijing No. 5 High School)

Li, Yuqian (School: Beijing No. 5 High School)

Per- and polyfluoroalkyl substances (PFAS) exhibit extraordinary chemical stability and environmental persistence, posing risks to ecosystems and public health. This study targets PFBA and PFOA with the objective of constructing an engineered E.coli capable of simultaneously detecting and degrading these compounds while maintaining stringent biosafety control. To build an integrated “detection–degradation–biosafety” platform, genes encoding a PFAS degradation pathway and a fluoride ion transporter were introduced into E.coli, together with fluorescent reporters for real-time sensing and an arabinose–inducible suicide circuit for controlled containment. Engineered strains were evaluated for growth performance, reporter activity, degradation indicators, and biosafety activation efficiency under multiple conditions. The engineered bacteria maintained stable growth across PFAS concentrations. Upon PFAS exposure, fluorescence intensities were markedly elevated compared to wild-type controls, reflecting effective sensing. Formation of white precipitates occurred only after adding acidified calcium chloride to engineered cultures, suggesting PFAS defluorination and fluoride release. A L-arabinose concentration of 0.6 g/L triggered effective activation of the suicide module. Key results of this work include: (1) the simultaneous integration of PFAS detection, transport, and degradation functions into a single chassis; (2) the use of a fluoride-responsive precipitation assay as a low-cost indicator of degradation progress; (3) a tunable genetic containment system designed for environmental deployment. Together, these results ddemonstrate a modular, biosafe, and multifunctional engineered E coli platform with potenial applications in PFAS monitoring and bioremediation.

Awards Won: