Tricks of the trade: approaches for enhancing microbial bioreporters' performance

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Abstract

The relative ease by which molecular sensing and reporting elements can be fused together in microbial whole-cell biosensors to generate dose-dependent quantifiable physical (luminescent, fluorescent, colorimetric, electrochemical) responses to pre-determined conditions allows the construction of diverse classes of sensors. Over the last two decades we and others have employed this principle to design and construct microbial bioreporter strains for the sensitive detection of either (a) specific chemicals of environmental concern (e.g. trinitrotoluene), or groups of compounds sharing either (b) chemical characteristics (e.g. heavy metals, halogenated organics etc.) or (c) global biological effects on living systems (e.g. toxicity or genotoxicity). In many of these cases, additional molecular manipulations beyond the initial simplistic sensor-reporter fusion may be highly beneficial for enhancing the performance of the engineered sensor systems. We have recently described the remote detection of buried landmines using alginate-encapsulated fluorescent microbial (*Escherichia coli*) bioreporters (Belkin et al. 2017, Nature Biotechnol. 35: 308-310). Using this application as a case study, several of the approaches we have adopted over the years to enhance bioreporters' performance will be highlighted. These include random mutations induced in a "directed evolution" process, splitting of the *lux* reporter cassette, introduction of viral "amplifiers", manipulation of host permeability and the integration of quorum sensing elements.

Keywords: Bioluminescence, Fluorescence, Biosensors, Microbial bioreporters, Explosives, Remote detection

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