Title
Metabolic engineering of microorganisms for actinide and heavy metal precipitation

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Metabolic engineering of microorganisms for actinide and heavy metal precipitation

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Actinide precipitation by phosphate secretion

Project Goals

- Biologically precipitate aqueous actinides on Deinococcus radiodurans as phosphate complexes.
- Engineer accumulation and degradation of intracellular stores of polyphosphate under highly radioactive and stressful conditions
- Precipitate uranyl phosphate from uranium waste on the cell surface in a bioreactor
- Combine bioprecipitation with organic bioremediation functionality

Actinide chemistry and P secretion of Deinococcus radiodurans

HPI protein layer displays C-term

Incredible Radiation Resistance

Energy-dispersive X-ray spectroscopy

Fluorescence spectroscopy of metal challenged cells

Sum Frequency Generation IR


Phosphate starvation

Phosphate released from intracellular stores of polyphosphate under highly radioactive and stressful conditions
- Precipitate uranyl phosphate from uranium waste on the cell surface in a bioreactor
- Combine bioprecipitation with organic bioremediation functionality

Phosphate starved cells were initially fed 0.132 mM rather than 1.32 mM Pi. 1.32 mM Pi was added to all cells upon induction w/ 1 mM IPTG. The resulting polyP accumulation was 100 fold higher in induced cells, and approximately twofold higher in phosphate starved cells.

Replacement of inorganic phosphate with an organic phosphate source, such as glycerol-2-phosphate, may be a potential strategy to reduce radiation sensitivity and improve cell survival in highly radioactive environments.

Deinococcus radiodurans was shown to be capable of removing relatively high levels of uranyl from water, including actinides, heavy metals, and organics using the engineered organisms; and (3) to confirm the potential for actinide removal from contaminated waste streams or immobilizing these elements in situ.

Energy-dispersive X-ray spectroscopy of metal challenged cells

Sum Frequency Generation IR

Ultra violet exposure, typically caused by solar radiation, is known to be a significant stressor for microorganisms. The results of the study show that Deinococcus radiodurans is capable of removing relatively high levels of uranyl from water, including actinides, heavy metals, and organics using the engineered organisms; and (3) to confirm the potential for actinide removal from contaminated waste streams or immobilizing these elements in situ.

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Phosphate release

PolyP accumulation in HN854 pNSR20

Polyphosphate degradation in HN854 pNSR20

Transmission Electron Microscopy

Fluorescence spectroscopy of metal challenged cells

Incredible Radiation Resistance

IR and Fluorescence Spectroscopy

Sum Frequency Generation IR

UO$_2^+$-Cell Chemistry

Cyclotron Ion Irradiation

Phosphate released from intracellular stores of polyphosphate under highly radioactive and stressful conditions
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