E3B The Elements of Bioremediation, Biomanufacturing & Bioenergy Metals in Biology

Durham University · University of Kent · Manchester 1824 · Biotechnology and Biological Sciences Research Council

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POCE3B033 BB/S009787/1

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Freeland HORTICULTURE LIMITED

# Bio-recovery of rare earth elements using Methylotrophs

*"This project allowed us to move from basic principles to experimental proof of concept, giving us the confidence to support the development of Methylotrophs as a biocatalyst for critical metal biorecovery."*
Andrew Goddard, Freeland Horticulture.

**PROJECT AIMS:** Our ultimate objective is to develop a green, aqueous bio-recovery process for rare earth elements (REEs). Here we focus on demonstrating the feasibility of *in-vivo* REE binding using methylotrophic bacteria. We used a high-throughput screening platform to develop and demonstrate robust industrial methylotrophic bacteria strains that bind La, Ce, Pr and Nd with high affinity.

**RESULTS:**
For the first time, we established the capacity REE bio-absorption using whole-cell biocatalyst Methylotrophs. In more detail, we:

- demonstrated the high-affinity binding of four REEs, namely La, Ce, Pr and Nd, individually and in a mixture, from low to high concentrations in two Methylotroph stains.
- automated the workflow of a REE binding growth assay and sample preparations for ICP-MS.
- demonstrated DNA transfer in one Methylotroph stain.
- demonstrated genetic engineering of a Methylotroph using our proprietary CRISPR technology, successfully deleting two key genes in REE uptake pathways.

**Change in technology readiness level: 1 to 2/3**

**OUTCOMES & NEXT STEPS:**

- An EPSRC Standard Grant bid, ca. £1.1 M, collaborating with Sheffield Hallam University, was submitted in Sept 2023. The project is entitled 'Versatile and sustainable routes for critical metal biorecovery'.

- A BBSRC iCASE Studentship in Industrial Biotechnology — ca. £115,400 and £4,000 Industrial cash contribution — with Freeland Horticulture has been awarded. The project is entitled '*Precious metal bio-recovery using a microbial factory*'.

Methylotrophs, that originated in soda lakes, can bio-absorb a mixture of rare earth elements (REEs), and this process is being improved.