MICROBIOME TECHNOLOGY FACT SHEET

Automated Synthetically-Primed Evolution of new biodegradative activities

Spanish National Research Council (CSIC) technology
developed under the EU-funded NYMPHE project

PROBLEM

MANY EMERGING POLLUTANTS (E.G., PHARMACEUTICALS AND NITROAROMATICS) PERSIST IN THE ENVIRONMENT BECAUSE NATURAL MICROBIAL PATHWAYS FOR THEIR DEGRADATION ARE ABSENT, INEFFICIENT, OR TOO SLOW. CONVENTIONAL BIOREMEDIATION CANNOT KEEP PACE WITH THE DIVERSITY AND COMPLEXITY OF THESE CONTAMINANTS.

Target pollutants:

Model compounds (e.g., 2,4-dinitrotoluene) and environmentally relevant micropollutants (diclofenac, ibuprofen, paracetamol).

TECHNOLOGY

System setup:

- Bacterial chassis: Pseudomonas putida (recognized bioremediation host).
- Introduction of genes encoding new biotransformation activities.

Operation:

- Initial genes are unoptimized for host's metabolic and genomic context.
- Recursive laboratory evolution applied, supported by an OpenTrons-type robotic platform.
- Iterative "molecular negotiation" between inserted genes and host regulatory/metabolic networks.

Function:

- Generation of evolved bacterial strains with enhanced pollutant degradation capacity.
- Strains tailored for efficient bioremediation of complex or persistent contaminants.

NYMPHE
Funded by the European Union

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INNOVATION

Ambition:
Combine adaptive laboratory evolution with synthetic biology to create new biocatalysts.

TRL:
Prototype stage.

Novelty:
Integration of two traditionally separate approaches to generate entirely new microbial capabilities for pollutant degradation, beyond conventional bioremediation.

RESULTS

- Preliminary results show potential for generating whole-cell catalysts capable of degrading compounds previously considered highly resistant.
- Enables faster development of efficient biodegradative strains for model and environmental pollutants.
- Provides a platform for rapid adaptation and optimization of biodegradative pathways in controlled conditions.