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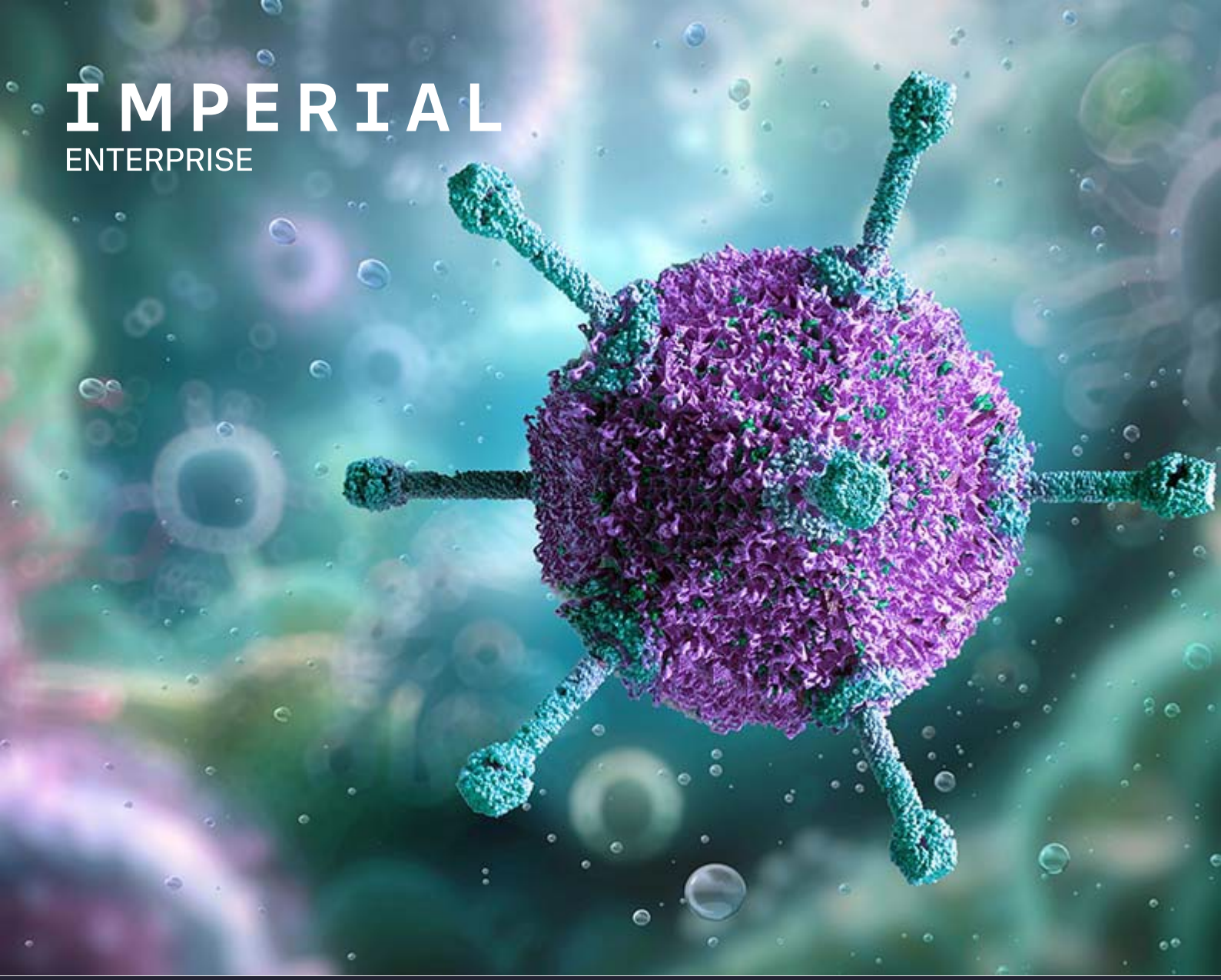

Broad-range infective particles for DNA delivery across bacterial species

A platform based on capsid-forming PICIs (cf-PICIs) that self-assemble into particles able to borrow phage tails, creating hybrids that deliver engineered DNA across diverse bacteria for targeted therapies and diagnostics.

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Intellectual property information
UK Priority Application filed February 2025 – GB2501620.5 – Chimeric Particles

Inventor information
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Proposed Uses

cf-PICIs can be engineered as a versatile platform for precision antibacterial therapies and diagnostic tools. In therapeutics, they can be designed to deliver engineered DNA into harmful bacteria, allowing for the selective killing of pathogens, including antibiotic-resistant strains, while sparing beneficial microbes. For diagnostics, cf-PICIs can carry marker genes such as fluorescent or enzymatic reporters, enabling the identification and tracking of specific bacterial strains within complex samples. Beyond medicine, this system also offers a powerful biotechnology tool, providing a modular DNA delivery system for manipulating bacterial populations or studying microbial communities with high precision.

Problem addressed

Phage-based therapies and related elements such as PICIs and satellites face a critical limitation: their narrow host range. Each phage or PICI typically infects only certain bacterial species, and often only a subset of strains within that species. This restriction arises from the phage tail, which dictates which bacteria can be infected. Despite decades of research, attempts to re-engineer phage tails to expand their host range have achieved only slow and incremental progress. As a result, the potential of phages and satellites as antibacterial therapies or diagnostic systems has been severely restricted.

Technology Overview

The discovery of capsid-forming PICIs (cf-PICIs) introduces a novel biological mechanism that overcomes these limitations. cf-PICIs are able to assemble their own capsids but are released without tails, leaving them harmless by default. However, they can interact with and “borrow” tails from unrelated phages, producing infectious chimeric hybrids. These hybrids inherit the targeting ability of the borrowed tail, which enables cf-PICIs to deliver DNA broadly across species or with high strain-specific precision. By engineering the DNA cargo within cf-PICIs, they can be designed as smart therapeutic particles that kill only target bacteria, or as diagnostic tools that generate detectable signals in chosen strains. This platform breaks through the long-standing host-range barrier in phage biology, offering a scalable and adaptable alternative to antibiotics and conventional phage therapies.

Publications

Penadés, J, Gottweis,J et al. (2025). AI mirrors experimental science to uncover a mechanism of gene transfer crucial to bacterial evolution, Cell. DOI: 10.1016/j.cell.2025.08.018

Lingchen, H, Patowski, J, Penadés, J et al. (2025). Chimeric infective particles expand species boundaries in phage-inducible chromosomal island mobilization, Cell. DOI: 10.1016/j.cell.2025.08.019

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Benefits

Precision antibacterial therapies

- Selectively kill harmful bacteria, including antibiotic-resistant strains, while sparing beneficial microbes
- Overcome the narrow host range of traditional phage therapies by borrowing tails from diverse phages
- Enable both broad-spectrum activity across species and fine-scale precision against specific strains

Advanced diagnostics

- Deliver harmless marker genes to produce fluorescent or enzymatic signals in target bacteria
- Enable rapid identification and tracking of specific bacterial strains within complex samples

Versatile biotechnology platform

- Provide a modular DNA delivery system for manipulating bacterial populations
- Facilitate research into microbial interactions, evolution, and community dynamics
- Scalable and adaptable for therapeutic, diagnostic, and industrial applications