Adelaide University

Cell-Free Viral Vector Platform

A scalable, low-cost platform for safe delivery of DNA and RNA therapeutics

Benefits

- Potential to be orders of magnitude cheaper than conventional viral vector systems
- Platform process that is independent of genetic cargo sequence
- Cell-free manufacturing, eliminating the need for cell culture systems
- Scalable, rapid, and low-cost production
- Compatible with both DNA and RNA payloads
- Non-infectious, with an improved safety profile compared with conventional viral vectors
- Mild processing conditions that help preserve nucleic acid integrity
- No encapsulation of host-cell DNA or RNA

Background

Genetic medicines, including mRNA vaccines and DNA-based gene therapies, require delivery systems that are both safe and efficient. Lipid nanoparticles can be manufactured rapidly and cost-effectively, but their toxicity profile limits their use at the high doses often required for gene therapy.

Conventional viral vectors, such as Adeno-Associated Virus (AAV), are typically produced in cell-based systems and face significant manufacturing and safety challenges. These include low yields, high levels of empty particles, unintended packaging of host-cell genomic material, and complex purification requirements. Together, these factors can drive the cost of goods to more than $100,000 per treatment.

A cell-free viral vector platform offers a potential solution. In this approach, viral shell subunits, or capsomeres, and genetic cargo are produced separately and then co-assembled in a controlled, cell-free environment. This enables greater control over vector composition, reduces cell-derived contaminants, and has the potential to improve yield, safety, scalability, and manufacturing cost.

Technology overview

This technology enables the rapid, cell-free assembly of viral vectors capable of encapsulating sequence-independent DNA or RNA payloads. By combining nucleic acids with viral capsid proteins under controlled salt conditions, particles self-assemble in vitro without the need for living cells.

Both the capsid proteins and genetic cargo can be produced at scale using standard, well-established, and cost-effective manufacturing processes. The platform leverages controlled ionic strength, typically in the range of approximately 0.05–0.4 M, to drive electrostatic interactions that enable capsid proteins, such as VP1 or L1, to form stable particles around the genetic payload.

Affinity ligands can also be incorporated into the viral shell to support targeted delivery, providing a flexible route to tissue- or cell-specific therapeutic applications.

Applications

- mRNA and DNA vaccines
- Gene therapy delivery
- RNA therapeutics (siRNA, mRNA, antisense)
- Oncology treatments
- Neurological disease delivery
- Research and cell engineering tools

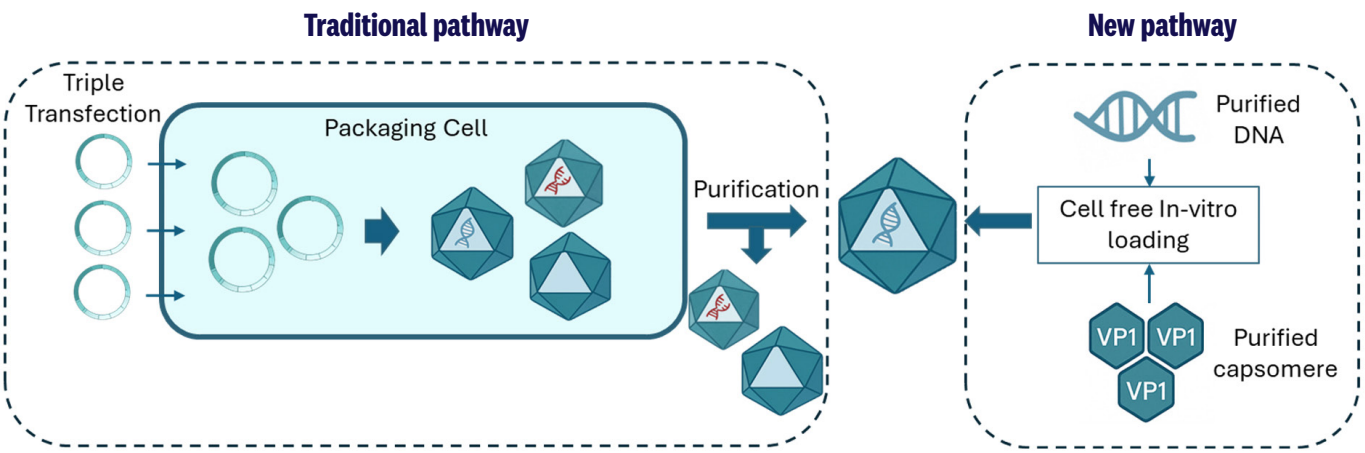

Figure 1: Possible manufacturing pathways for viral vectors: Traditional pathway relies on uncontrolled in-vivo assembly in packaging cells, producing mostly incorrect/inactive/empty viral vectors. The proposed pathway utilised cell free controlled assembly of viral structural proteins and genetic cargo.

Development Status

The Technology has been validated at laboratory scale demonstrating successful assembly of RNA- and DNA-loaded virus-like particles (VLPs). Process optimisation includes control of salt concentration, nucleic acid ratio, and incubation conditions to maximise yield and stability.

IP Status

Provisional Patent application filed in December 2025 - 2025906722.

Opportunity

Platform technology targeting the global genetic medicine and drug delivery markets.

Indicative markets:

- mRNA therapeutics and vaccines
- Gene therapy
- Drug delivery technologies

Commercial pathways include licensing, co-development partnerships, and platform integration into pharmaceutical pipelines.

Inventor

Dr Lukas Gerstweiller, Adelaide University

Email: lukas.gerstweiler@adelaide.edu.au

Commercial Contact

Aisha Sirop, Senior Commercialisation Manager
Research & Innovation, Adelaide University

Email: Aisha.sirop@adelaide.edu.au
Phone: +61 8 8313 3283
Web: adelaide.edu.au/research/partnered-research/

PRV14404 / CRICOS 04249J
Published June 2026
COR-229