Phages in Nanotechnology

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Nanotechnology

- The definition of nanotechnology is based on the prefix "nano" which is from the Greek word meaning "dwarf".
- In more technical terms, the word "nano" means 10^{-9}, or one billionth of something. For a meaningful comparison, a virus is roughly 100 nano
- There are three major physical properties of nanoparticles, and all are interrelated:
- 1) Quantum effect- related to magnetic properties, size, momnetum
- 2)Large Surface to Area ratio
- 3) Self Assembly

Introduction (Wikipedia)

- Virus nanotechnology is the use of viruses as a source of nanoparticles for biomedical purposes.
- Most virus capsids measure between 20-500 nm in diameter. Because of their nanometer size dimensions, viruses have been considered as naturally occurring nanoparticles.
- Virus nanoparticles have been subject to the nanoscience and nanoengineering disciplines. Viruses can be regarded as prefabricated nanoparticles.
- A highly interdisciplinary field, viral nanotechnology occupies the interface between virology, biotechnology, chemistry, and materials science.

Viral nanotechnology

- The fields employs viral nanoparticles (VNPs) and its counterparts of virus-like nanoparticles (VLPs) for potential applications in the diverse fields of electronics, sensors, and most significantly at clinical field
- Nanotechnology is the manipulation or self-assembly of individual atoms, molecules, or, molecular clusters into structures to create materials and devices with new or vastly different properties.
- Douglas and Young (Montana State University, Bozeman, MT, USA) were the first to consider the utility of a virus capsid as a nanomaterial. CCMV showed a highly dynamic platform with pH and metal ion dependent structural transitions. Douglas and Young made use of these capsid dynamics and exchanged the natural cargo (nucleic acid) with synthetic materials.
- Rod-shaped particles of TMV (Tobacco Mosaic Virus)- The particles were used as templates for the fabrication of a range of metallized nanotube structures using mineralization techniques

VLP and VNP

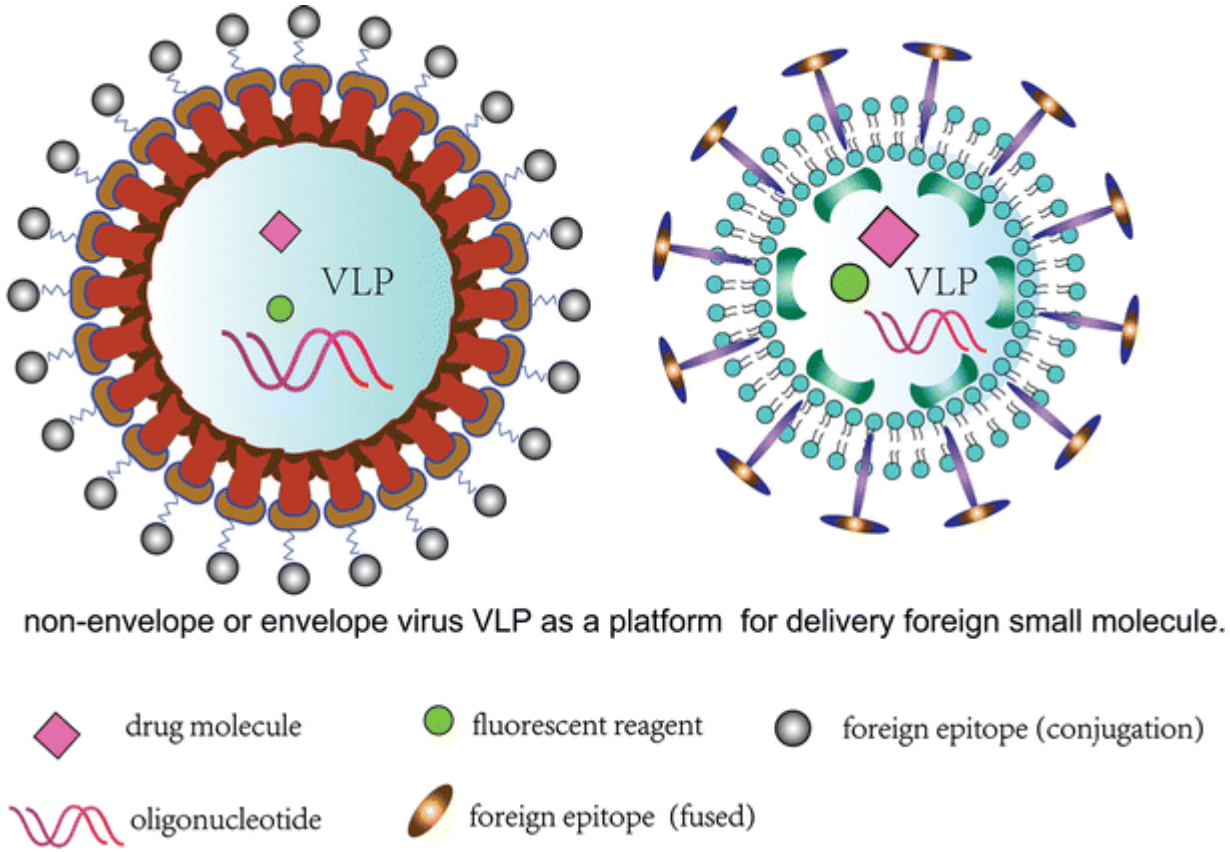
Virus-like particles (VLPs) are molecules that closely resemble viruses, but are non-infectious because they contain no viral genetic material. They can be naturally occurring or synthesized through the individual expression of viral structural proteins, which can then self assemble into the virus-like structur

- Viral capsids have attracted great interest in the field of nanobiology because of their
- nanoscale size,
- symmetrical structural organization
- load capacity
- controllable self-assembly, and
- ease of modification. V
- Viruses are essentially naturally occurring nanomaterials capable of self-assembly with a high degree of precision

Advantages of VNP and VLP

- Both particles are on the nanometer-size scale;
- they are monodisperse with a high degree of symmetry and polyvalency
- they can be produced with ease on large scale
- they are exceptionally stable and robust
- and they are biocompatible
- They are "programmable" units that can be modified by either genetic modification or chemical bioconjugation methods.
- Delivered as therapeutic agents eg orally

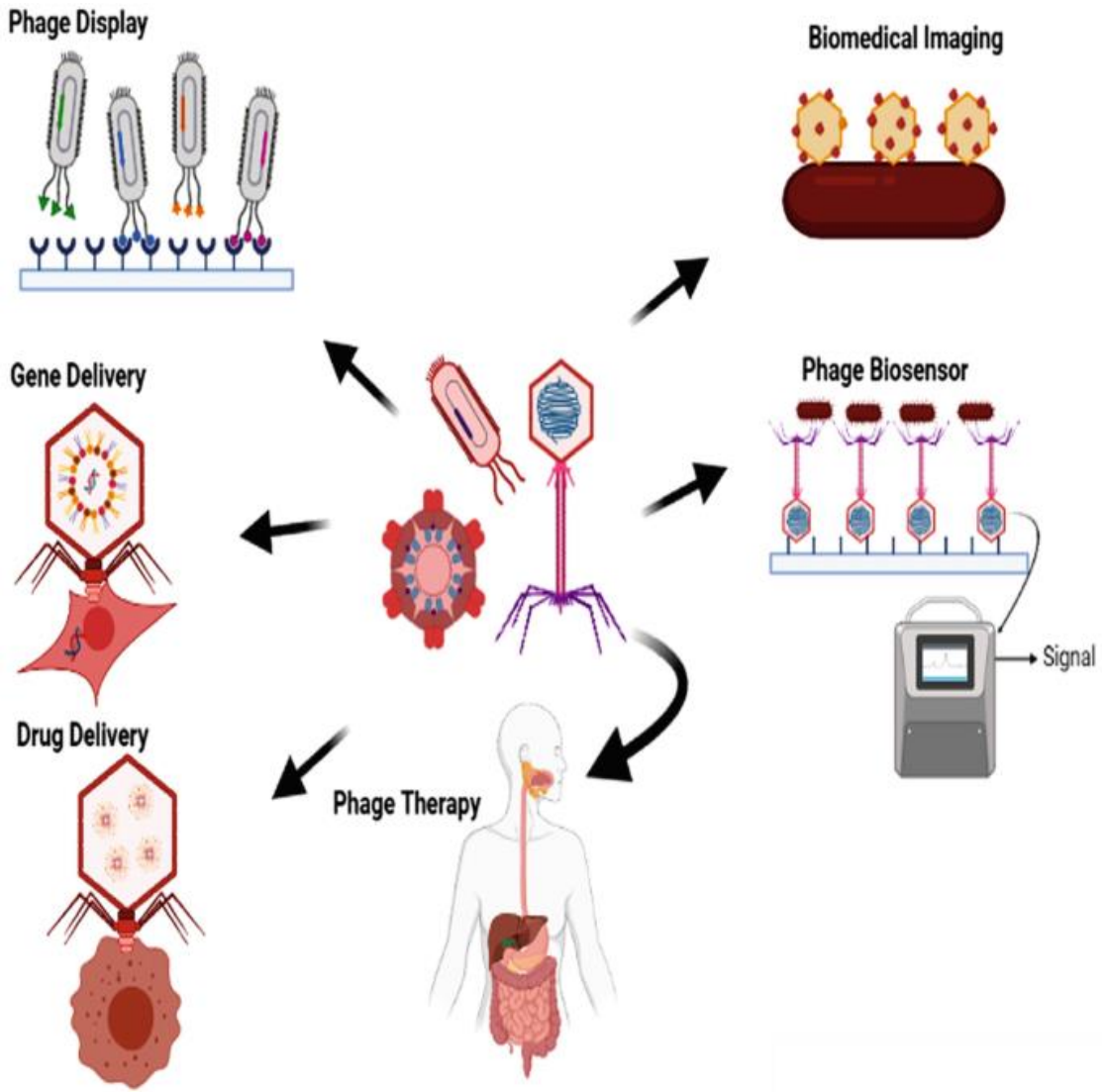
Examples of Applications



- Yan, D., Wei, YQ., Guo, HC. et al. The application of virus-like particles as vaccines and biological vehicles. Appl Microbiol Biotechnol 99, 10415–10432 (2015). https://doi.org/10.1007/s00253-015-7000-8

Applications

- Biosensors
- Therapy
- Diagnostics
- Piezoelectric effects- M13 phage (the ability of certain materials to generate an electric charge in response to applied mechanical stress)



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