

# AUBURN UNIVERSITY

## INNOVATION ADVANCEMENT & COMMERCIALIZATION

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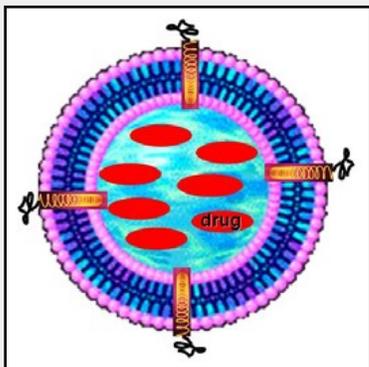
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Reference: Phage Liposomes

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### Reference

Jayanna, P.K., Torchilin V.P.,  
Petrenko, V.A. "Liposomes  
targeted by fusion phage  
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## Drug Delivery Using Liposomes Targeted With Landscape Phage

### Overview

Auburn University is seeking a licensee or development partner for a technology using landscape phage as a bio-selective element for lipid nanocarriers, such as liposomes and micelles. As superior substitutes for antibodies, phage demonstrate many features such as high affinity for the analyte, field stability, and low cost. In addition, the phage can be incorporated into formulations via self-assembly, eliminating complicated conjugation processes that exhibit high cost, low purity and batch-by-batch variability.

### Advantages

- Incorporation of phage based on self-assembly, requiring no sonication, dialysis or chemical conjugation, providing simple, low cost and consistent production
- Can be added during production or incorporated into pre-fabricated formulations
- Phage are produced at low cost and high purity
- Phage exhibit higher affinity and higher thermostability than antibodies
- Binding motif preferentially on exterior of particle, increasing binding and efficiency
- Tumor- or patient-specific phage probes can be selected, improving targeting specificity
- Can be used with any drug/liposome or drug/micelle combination

### Description

In order to achieve more specific drug targeting, carrier particles are modified with various ligands such as antibodies or peptides using advanced conjugation procedures. These conjugation procedures are effective for small scale production, but would be significantly less efficient when moved to large scale production where standardized pharmaceutically acceptable preparations will be required. High costs, low purity, and variations in the final product are all issues that must be overcome. In addition, antibodies are inherently expensive to produce. Accordingly, there is a need for an easily assembled targeted carrier particle that has efficient assembly/conjugation, little bioreactivity, specificity and selectivity in binding target sites, and can be efficiently produced on a large scale. Landscape phage express proteins in their coat that can be manipulated and screened to specifically bind to a variety of targets. This Auburn invention utilizes these proteins and their ability to become spontaneously associated with micelles and liposomes from their intrinsic function as membrane proteins. Thus, association of the binding element with the drug carrier occurs from self-assembly, which significantly reduces the difficulty, variability, purity and expense involved in conjugation. Phage also exhibit several inherent advantages over antibodies, including lower cost of production, higher affinity and higher thermostability. Also, tumor-specific or patient-specific phage may be selected *in vitro* or *in vivo*—after surgery or biopsy—further enhancing targeting specificity.

### Status

- Subject of U.S. Patents [8,137,693](#) and [8,252,324](#)
- Phage targeting MCF-7 breast cancer cells have been incorporated into a commercially available doxorubicin/liposome formulation; increased cytotoxicity similar to antibody-targeted liposomes has been shown with this formulation *in vitro*
- Effective delivery of siRNA has been demonstrated to MCF-7 cells *in vitro*

### Licensing Opportunities

- This technology is available for exclusive/non-exclusive licensing
- Joint development opportunities include research collaboration or joint venture