### Introduction

Liposomes

The flexible structure and self-assembly properties of liposomes have made them a major technology in the biomedicinal field. These spherical vesicles have been greatly investigated as drug delivery devices as well as models for the cell membrane.

#### Building them up

- Can be single or multilayered.
- Made up of polar head and hydrophobic tails.

#### Breaking them down

Breaking down liposomes is a beneficial technique in the pharmaceutical industry.

- Learn about undesired cells, such as cancer cells.
- Build multilayered liposomes from pieces allowing for the optimization of drug transfer.

### Previous Work with Modified Polypeptides

Prior research has been done studying the development of multilaminar vesicles from liposome fragments. These pieces have been produced using hydrophobically modified polypeptides (HMP). Nonpolar decyl groups that are attached along the polypeptoid backbone embed themselves into the bilayer, disrupting the structure of the liposome.

### Using Chitosan to Break Liposomes

Chitosan is a polysaccharide that is derived from the deacetylation of chitin, a polymer found in many insects, squid, and crustaceans such as shrimp, crab, and lobster. The crystalline structure of chitosan makes it insoluble in water. However, it has greatly been used in the biomedical field, such as in hydrogel formation.

#### Why Chitosan?

- More accessible
- Easier to manufacture/already assembled

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**Exploring Polymer-lipid Complexes for Potential Applications in Drug Delivery and Antimicrobial Systems**

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### Objective-Synthesizing Hydrophobically Modified Chitosan

Chitosan was hydrophobically modified with dodecyl alkyl chains, allowing the polymer to plant itself into the bilayer of the liposomes, like the polypeptoids. At high concentrations, it is hypothesized that the chains will disrupt the structure of the liposomes and break them into pieces. Modifications were made at various percentages, meaning out of the total monomer units in the sample, only 5, 10, or 25% of them were modified. Different molecular weights of chitosan were also tested: 50-190 kDa and 15 kDa.

#### Synthesizing HMC (50-190 kDa)

Low molecular weight chitosan (50-190 kDa) was 5%, 10%, and 25% hydrophobically modified with dodecyl alkyl chains.

#### HMC (50-190 kDa) + Liposome Interactions

The presence of the peaks due to 0 to 1.5 ppm indicate the successful modification with the dodecyl alkyl chain.

### HMC (15 kDa)

Low molecular weight chitosan (15 kDa) with 25% hydrophobic modifications was further modified with a carbonyl group.

#### HNMR (500 MHz) of 15 kDa HMC

It is possible that chitosan self-aggregation affects its ability to break down the liposomes. This is shown by the large intensity of the 0.1% (0% HMC) sample.

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**Water Soluble (WS) Chitosan (15 kDa)**

Low molecular weight chitosan (15 kDa) with 25% hydrophobic modifications was further modified with a carbonyl group.

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**Using Chitosan to Break Liposomes**

Chitosan and Liposome Interaction

The chitosan and liposome mixture increases in diameter rather than decreasing to the size of the liposome fragments (10-15 nm). Therefore, the liposomes did not break.

### Discussion and Future Work

#### Summary

- NMR and IR data support hydrophobic modification of the 50 kDa and 15 kDa chitosan.
- Low molecular weight chitosan (50 kDa) is impractical to work with because it either forms a gel or is difficult to dissolve.
- Current DLS data shows that the 25% HMC - 15 kDa does not break the liposomes. The increase in diameter of the chitosan and liposome mixture suggests that the chitosan is latching onto the liposomes, but not disrupting the structure enough to break it.
- Next Step:
  - Continue working toward collecting reproducible DLS data for the liposome and liposome interactions.
  - Perform Cryo-TEM to visually see liposome and HMC interactions.

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