Healthcare

Innovations in vaccine packaging and delivery

The COVID-19 pandemic was an unprecedented medical emergency that necessitated rapid vaccine production to reduce infection and the severity of infection. Inactivated and live-attenuated vaccines use killed or weakened versions of the germ to protect us, but the development of these can be pretty long. As many have probably heard, Pfizer and Moderna's most common COVID vaccines use messenger RNA (mRNA) technology. Protecting the mRNA and ensuring it enters the cells is a significant problem, so lipid nanoparticles (LNP) are used as a "shipping box" to deliver directly into the cells. The cells read the mRNA like blueprints to make a target protein. For COVID-19, it is the spike protein. After that, our cells display the spike protein in big quantities. The immune system learns how to defend itself from viruses from these spike proteins (**Fig.1,a**).

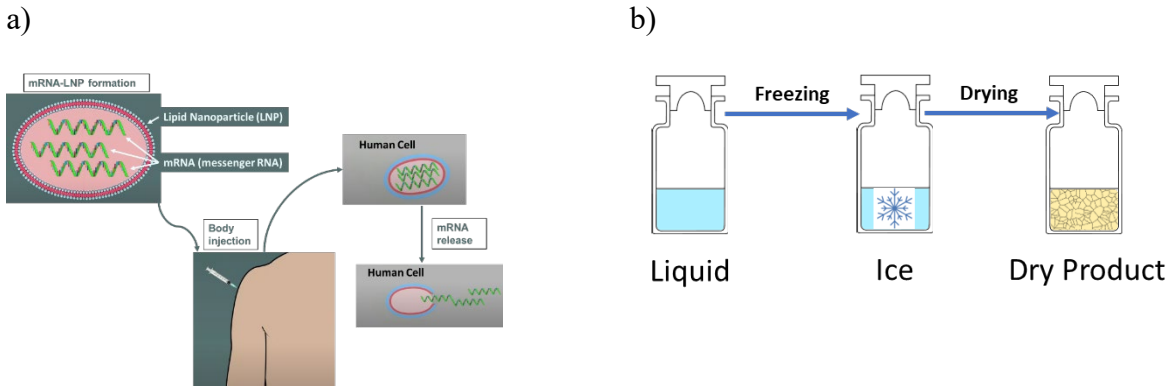

Figure 1: a) mRNA-LNP-based vaccine (formation, injection and release) b) Vaccine freeze-drying

Unfortunately, producing and storing these life-saving vaccines negatively impacts our environment by releasing large quantities of carbon into the atmosphere. At LyoHUB, we attempt to solve this issue by researching lyophilizing mRNA-LNPs to reduce this environmental burden. Lyophilization, also known as freeze drying (**Fig.1,b**), is the process of freezing a solution and sublimating the liquid, typically water, to dry the product. These lyophilized products have their water removed, so the individual doses of the vaccine are lighter, but more importantly, are stable outside of specialized freezers that the vaccines are currently stored in. To put this into perspective, lyophilizing the COVID vaccines to boost all eligible people in the United States would prevent over 7000 new cars' worth of carbon from being released. This would require 76 Central Park's worth of full-grown trees to offset this carbon release (**Fig.2**).

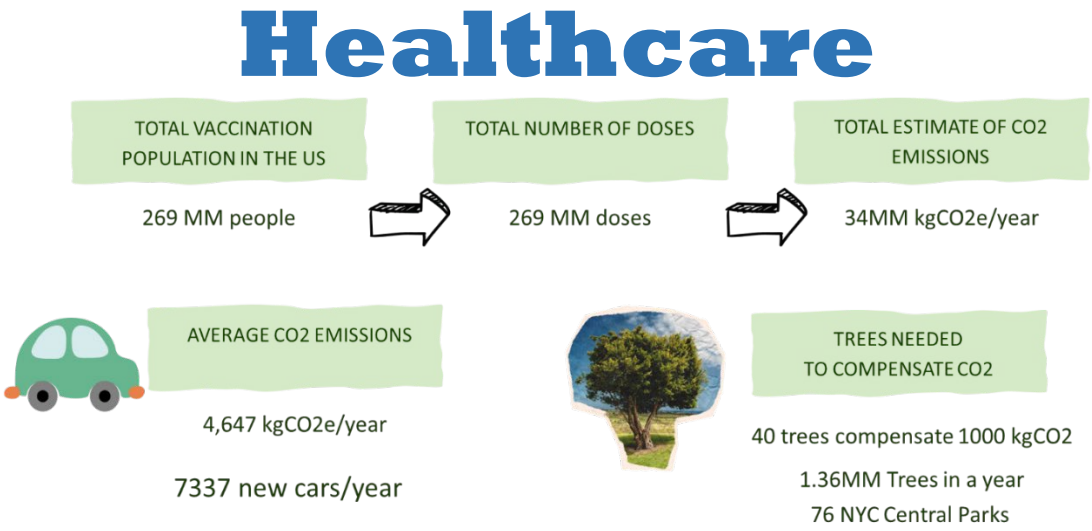

Figure 2: Carbon footprint due to vaccine production in USA

Advanced Lyophilization Technology Hub (LyoHUB) aims to advance the science and technology of freeze-drying/lyophilization. LyoHUB's members include companies in the pharmaceutical and food processing sectors, equipment manufacturers and university researchers, who combine their expertise and resources to accomplish the goal. Immediate objectives are: (i) to identify and disseminate Best Practices for lyophilization equipment performance, testing and validation and (ii) to conduct applied research to advance lyophilization processes and products. To learn more about our research and our members, please scan the QR code.

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