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Needleless Vaccination Against Arboviruses Using Dissolvable Microneedles

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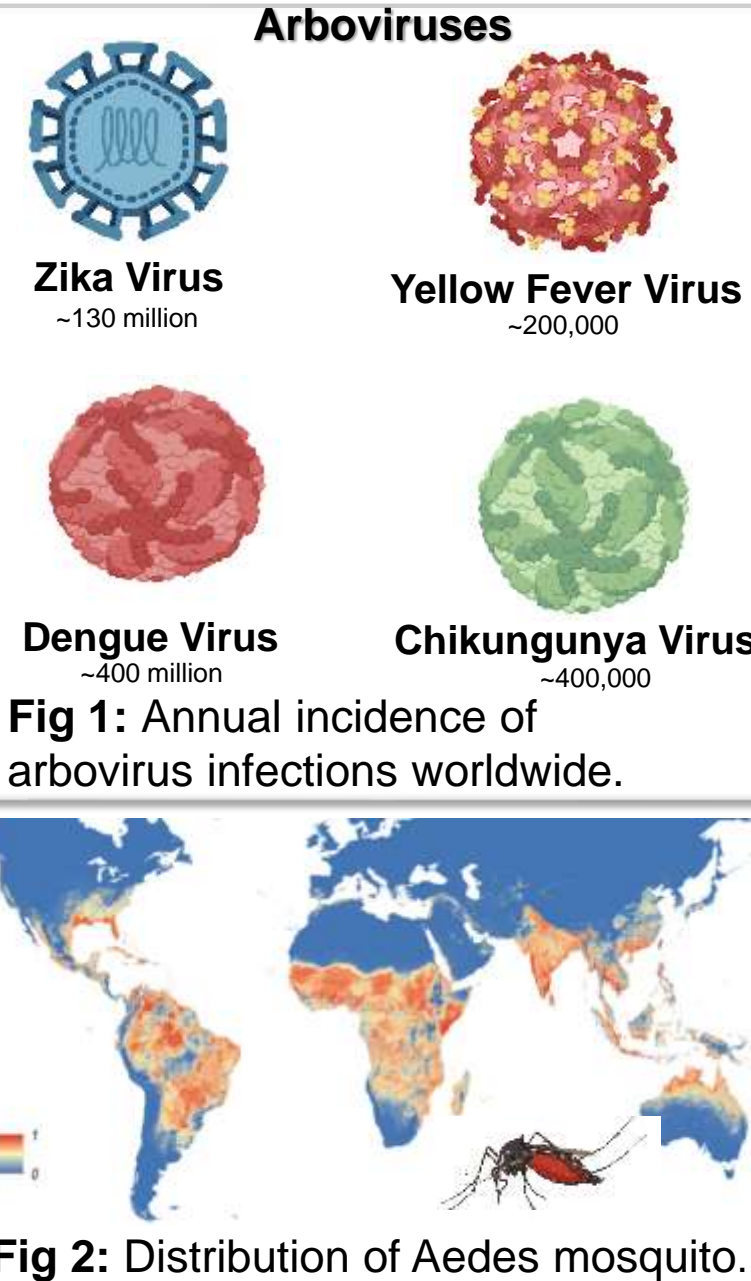
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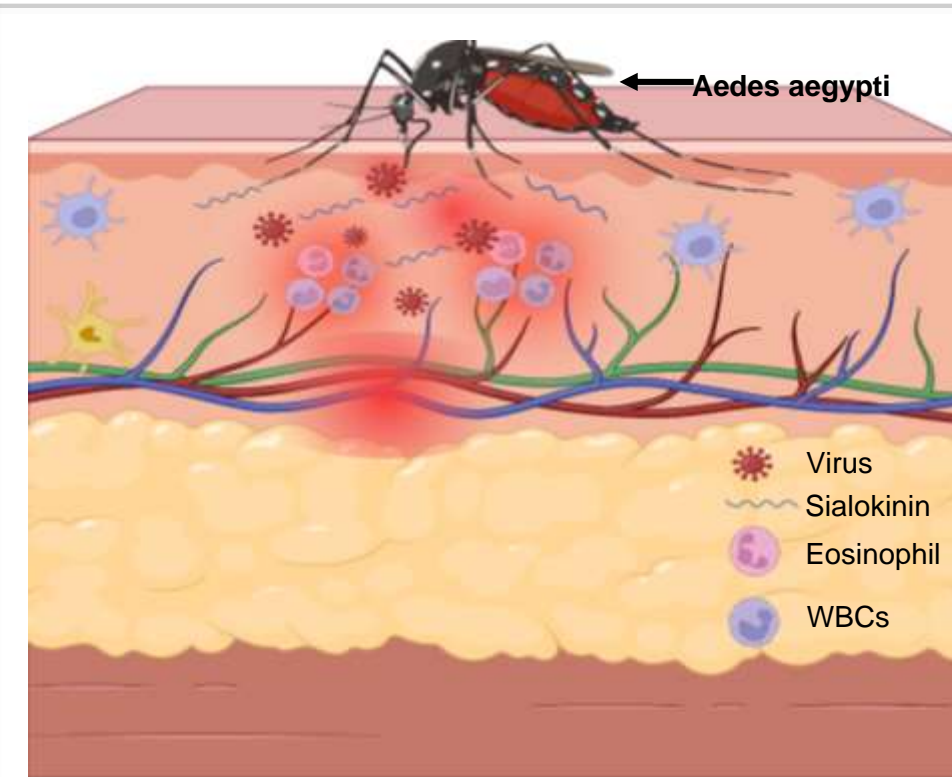
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Introduction

- Vaccines have saved approximately 1 billion lives and continue to be the **strongest defense against infectious outbreaks**.
- Concerns with traditional vaccines:** Temperature-sensitive (cold chain requirements), vaccine hesitancy, needle stick injuries, biohazard waste formation, etc.
- Millions of people are infected with **Arboviruses:** Dengue virus, Zika virus, Chikungunya virus, and Yellow fever virus. There are currently **no effective vaccines available** for many arboviruses, and the most effective treatment is the reduction of symptoms.
- Arboviruses spread through **Aedes mosquitoes**. Factors like globalization, urbanization, transportation, and climate change, are expanding Aedes' geographic range.



Methods



Results

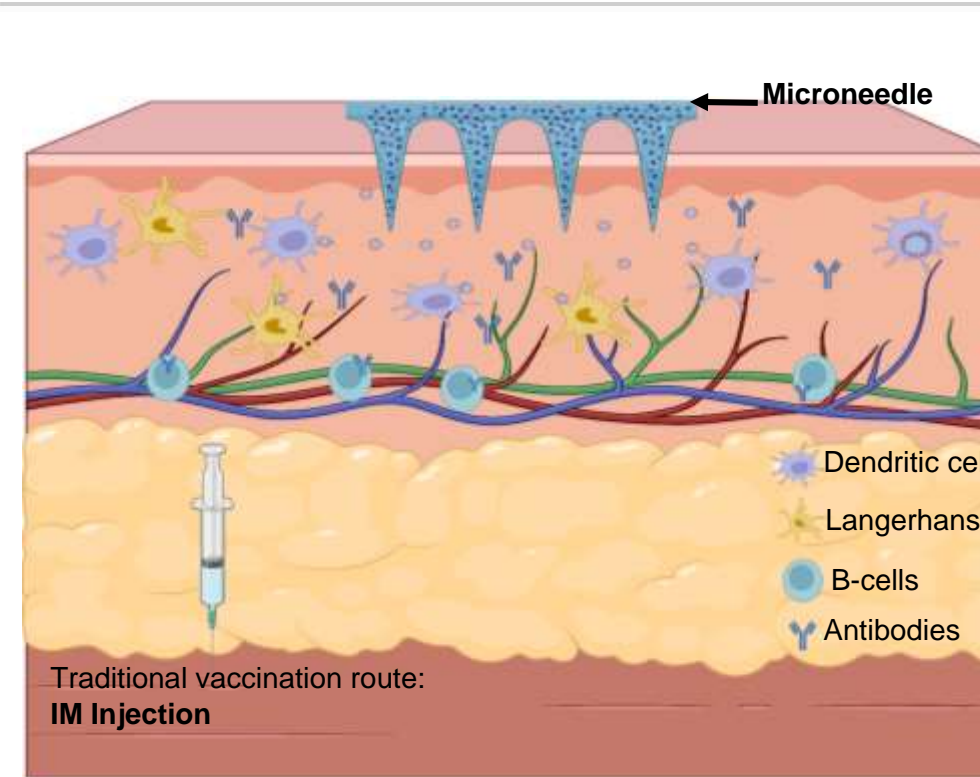


Fig 5: Microneedles release their cargo of virus-like particles (VLPs) at a **comparable depth** to that of Aedes mosquitoes when they deposit their virus and protein cocktail during a blood meal.

DLS Studies

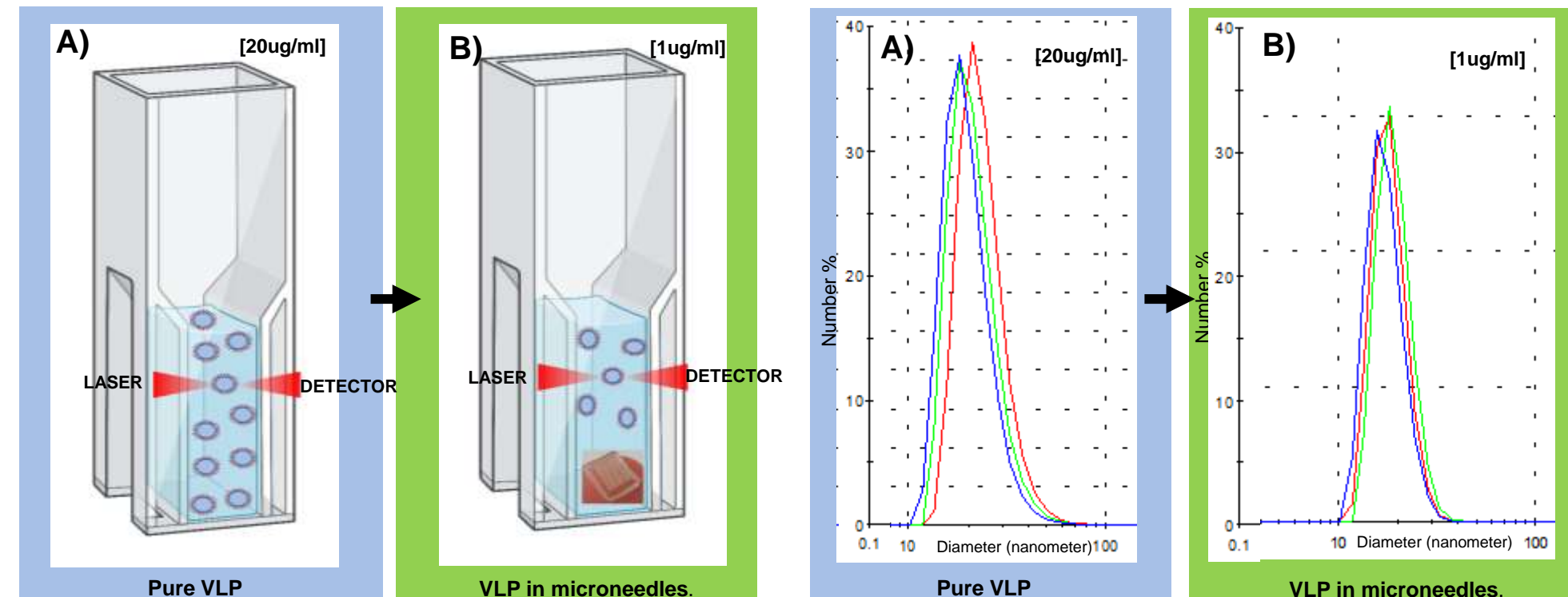


Fig 6: The Dynamic Light Scattering (DLS) data demonstrates that the size of the virus-like particle (VLP) remains **unchanged (~20nm)**, even after undergoing the microneedle fabrication process, providing robust evidence of the **integrity of the VLP**.

Ex-Vivo Skin Penetration Studies:

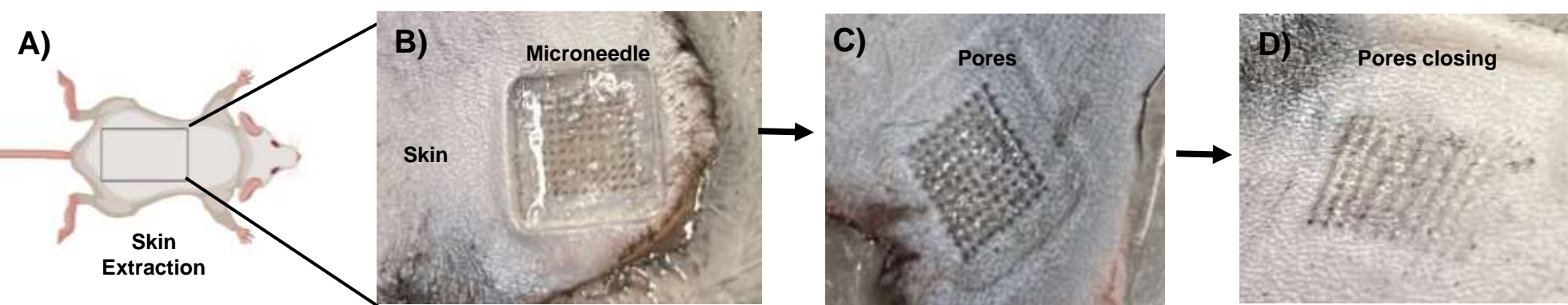


Fig 7: Depicts: **A)** Extraction of the skin from the dorsal region of the mouse; **B)** Insertion of the microneedle into the skin; **C)** Pores created after microneedle removal and **D)** Pores closing after ~15 minutes.

Results

Ex-Vivo Skin Dissolution Studies:

- The microneedles were used to penetrate the mouse skin for different time durations.
- Pre-and post-insertion imaging of the microneedle was conducted.

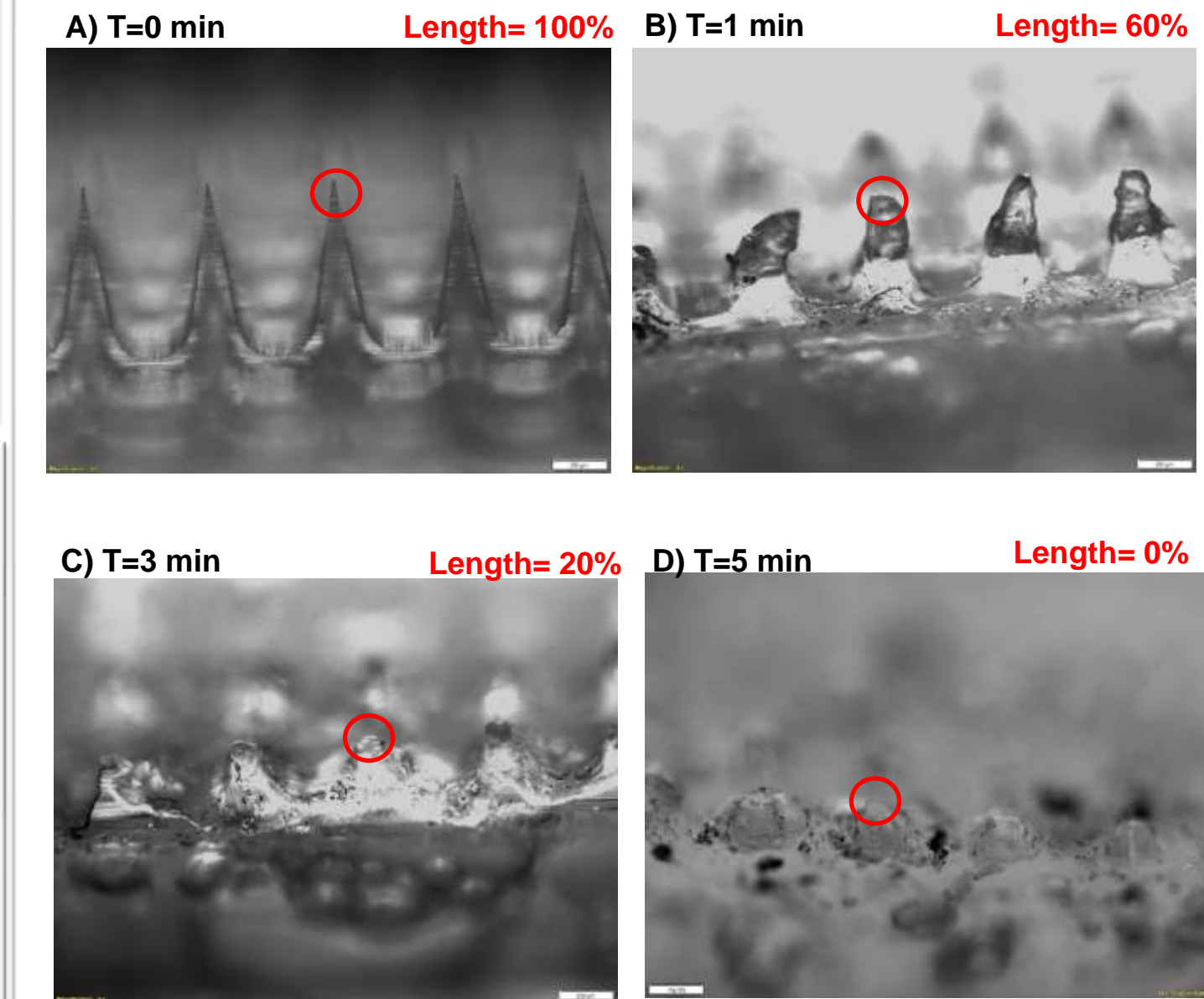


Fig 8: Dissolution over time (0,1,3 and 5 min).

Future Directions

- Multilayered microneedle for combination vaccines.
- Animal studies for evaluating immune response.
- Texture analyzer for examining microneedle strength.
- Long-term thermostability of microneedles.
- Quantifying VLP in microneedles.
- Optical Coherence Tomography (OCT) for pore-closing studies.

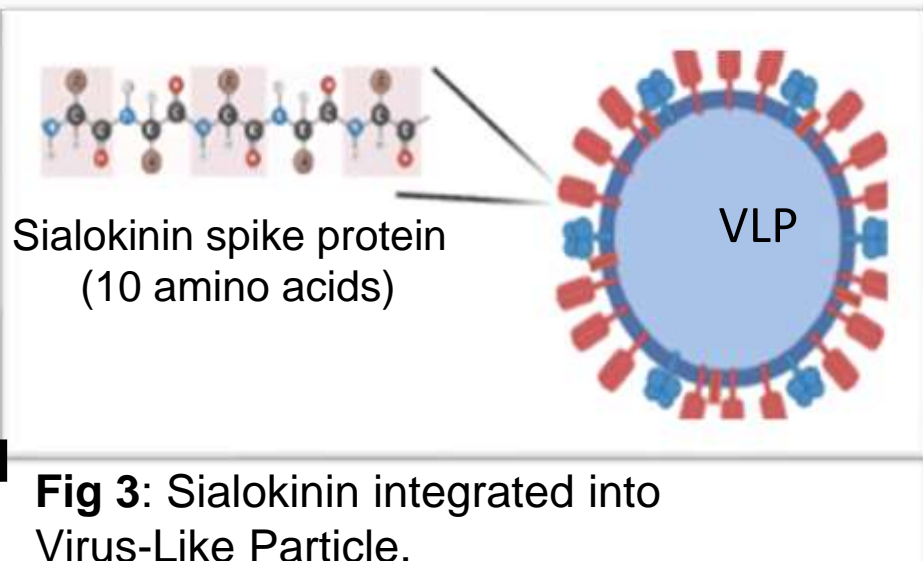
Acknowledgments

Tamara Howard- For Transmission Electron Microscopy
Karen Cooper- For IX-83 Microscopy.

Scientific Breakthrough:

We have incorporated Sialokinin VLP into Dissolvable Microneedles as a novel vaccination strategy.

- Sialokinin (Fig 2)** is a 10 amino acid peptide found in the saliva of Aedes mosquito and is responsible for increasing inflammation, and blood vessel permeability leading to **enhanced viral replication**.



- Dissolvable microneedles are an innovative vaccine delivery system that is: thermostable, pain-free, no sharp waste, easy to use, and highly immunogenic.

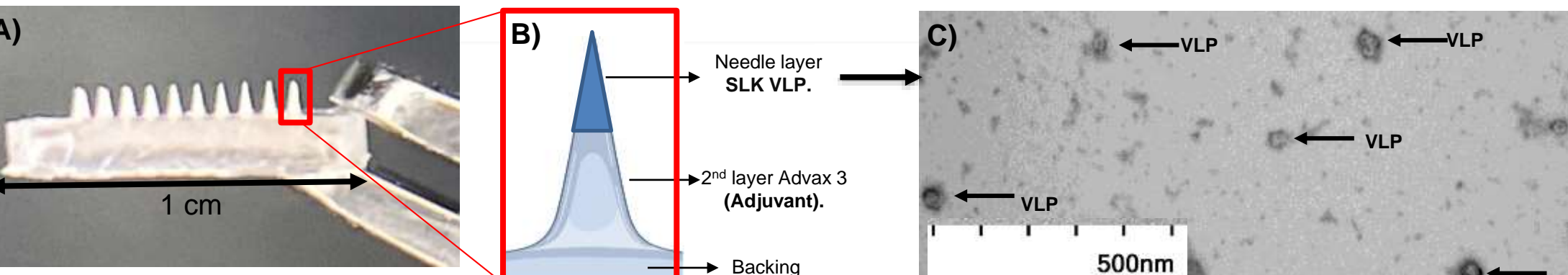


Fig 4: **A)** Rapid fabrication of microneedles within 24 hours by Micro molding **B)** Our needles are fabricated using a **three-layered design**. **C)** Transmission electron microscope (TEM) images reveal virus-like particles (VLPs) embedded within the needle layer.