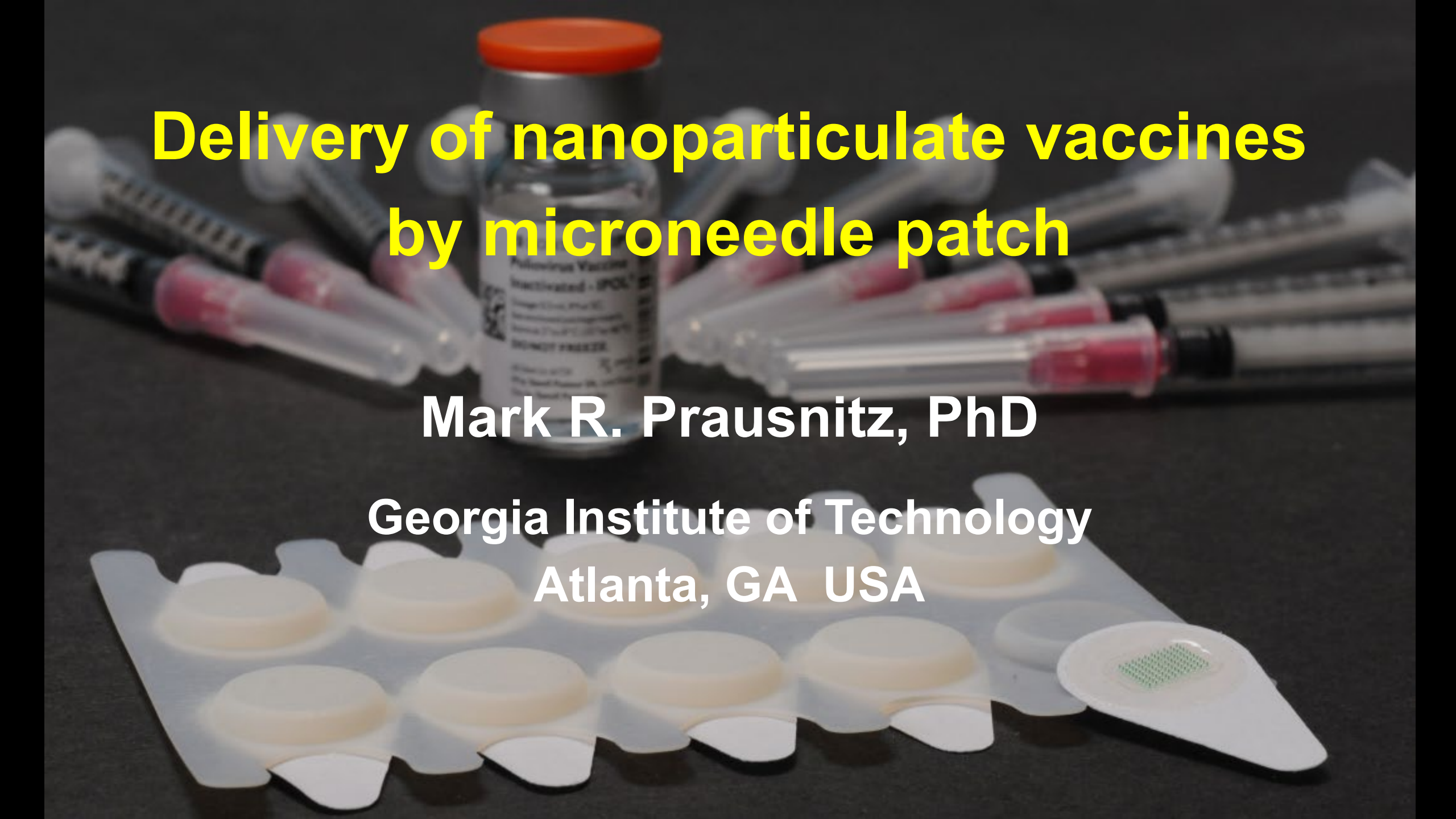




Delivery of nanoparticulate vaccines by microneedle patch

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Disclosure

Mark Prausnitz is an inventor of patents, co-founder and shareholder of companies, and consultant to companies developing microneedle technologies. This conflict of interest is managed by Georgia Institute of Technology.

Aldena Therapeutics
Alys Pharmaceuticals
Clearside Biomedical
Micron Biomedical
Microstar Biotech
Piezo Therapeutics
Serene Ophthalmic
Vimela Therapeutics

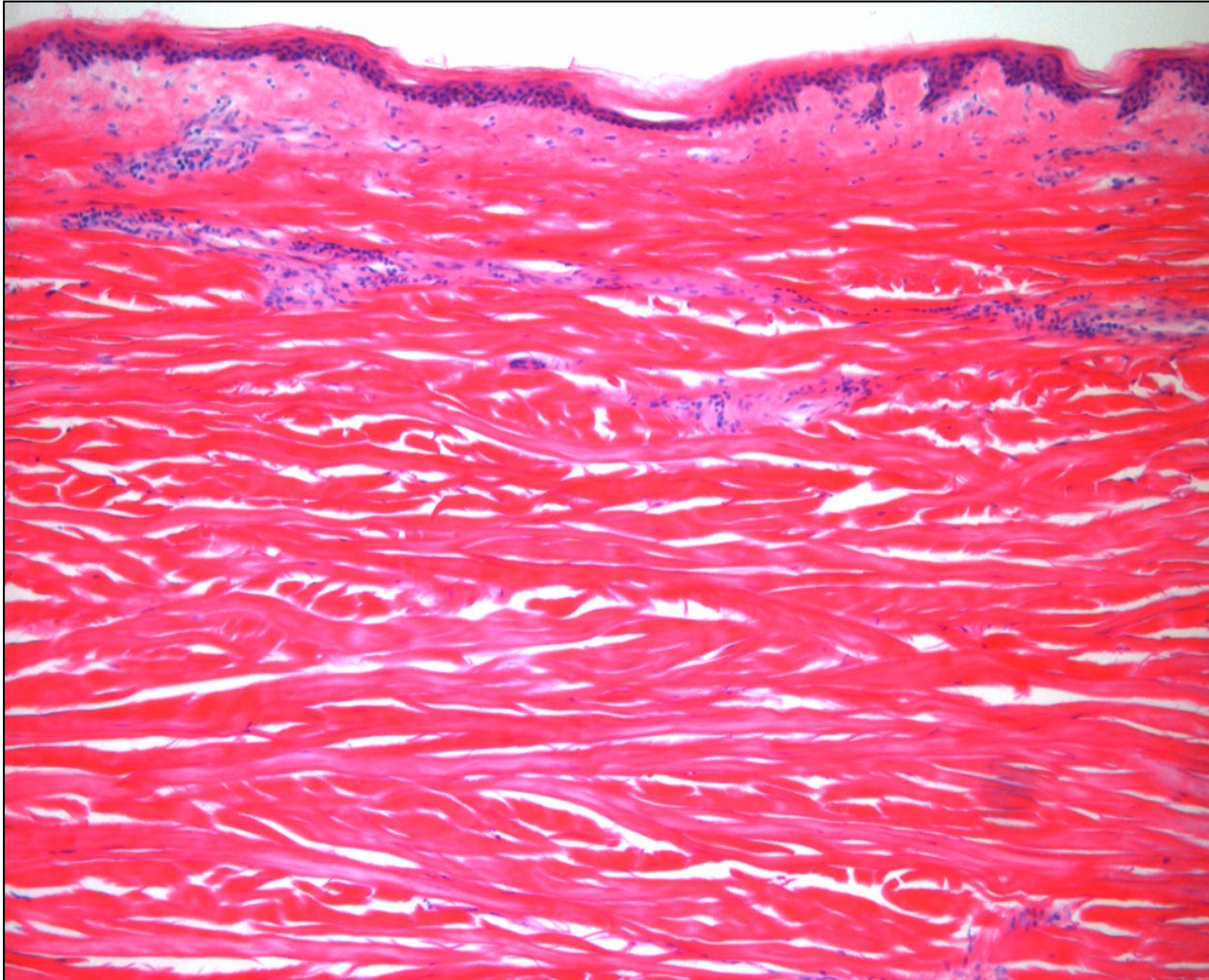
Types of vaccines

Vaccine type
Inactivated vaccines
Live-attenuated vaccines
Messenger RNA (mRNA) vaccines
Subunit, recombinant, polysaccharide, and conjugate vaccines
Toxoid vaccines
Viral vector vaccines

Types of vaccines

Vaccine type	Nanoparticulate form
Inactivated vaccines	Virus nanoparticle
Live-attenuated vaccines	Virus nanoparticle
Messenger RNA (mRNA) vaccines	Lipid nanoparticle
Subunit, recombinant, polysaccharide, and conjugate vaccines	Virus-like particle Alum adjuvanted
Toxoid vaccines	Alum adjuvanted
Viral vector vaccines	Virus nanoparticle

Skin vaccination has advantages



Stratum corneum

Delivery barrier

Viable epidermis

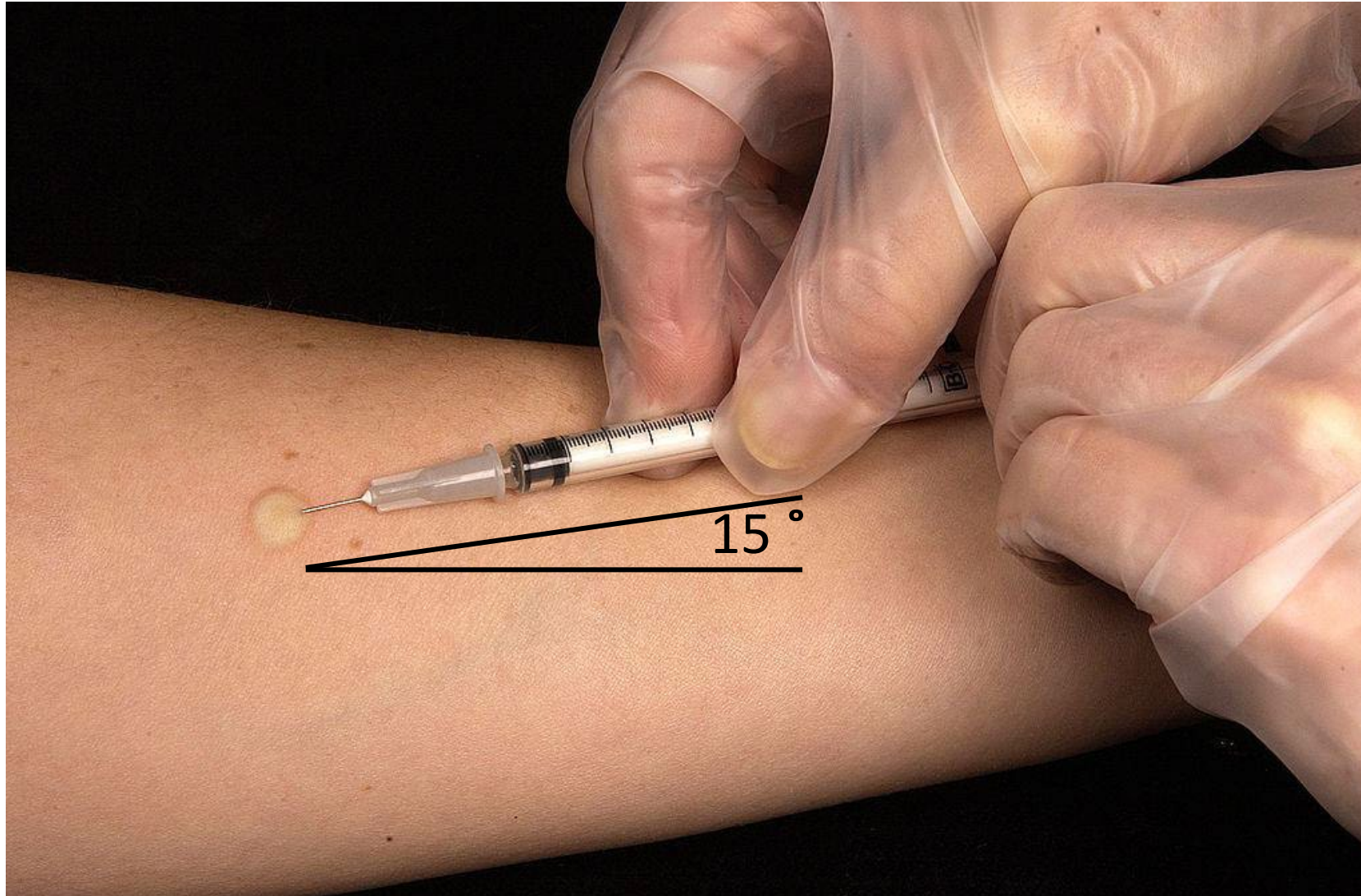
Langerhans cells

Dermis

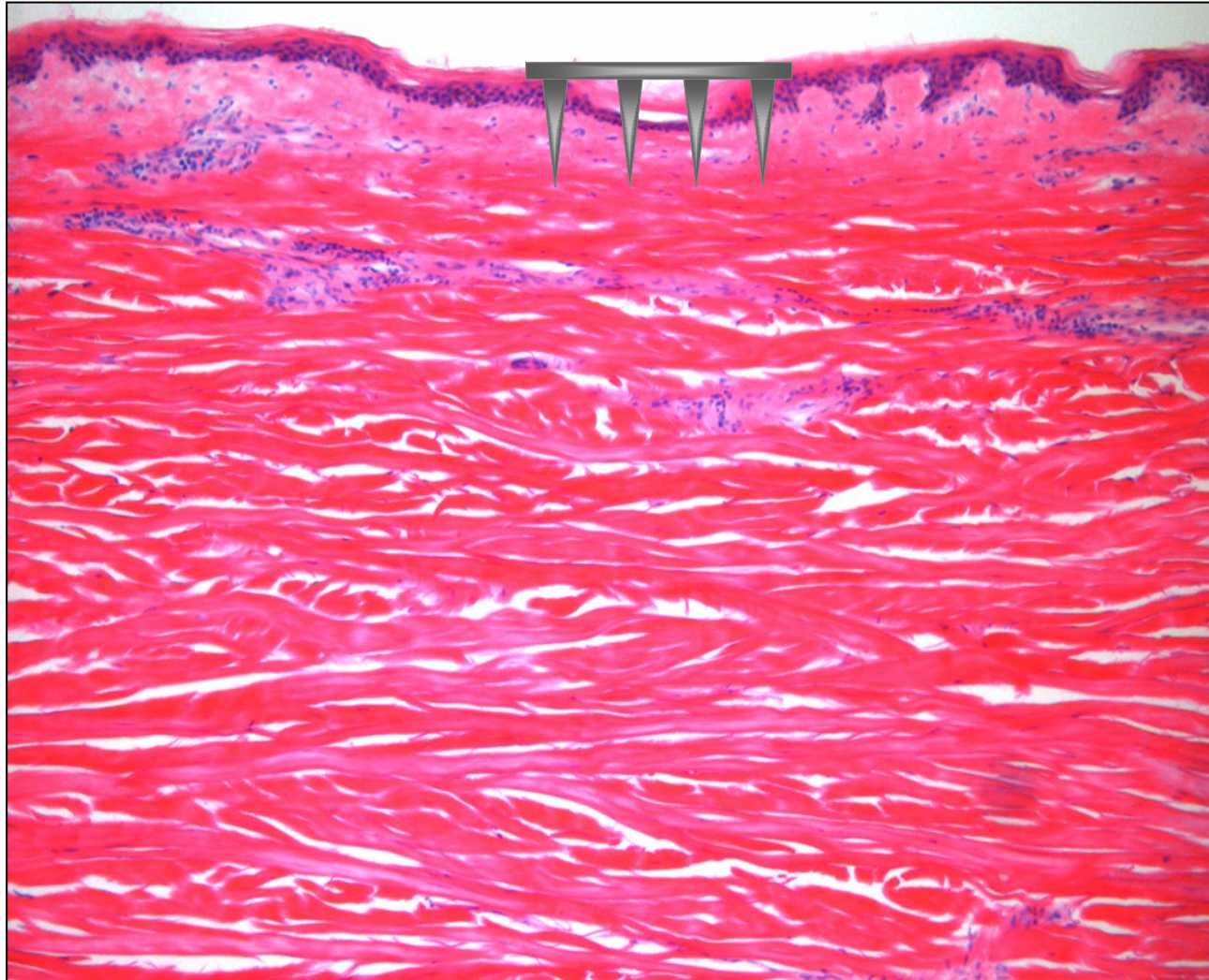
Dermal dendritic cells

Lymphatic drainage

Intradermal injection is hard to administer



Microneedle patches are simple to administer



Stratum corneum

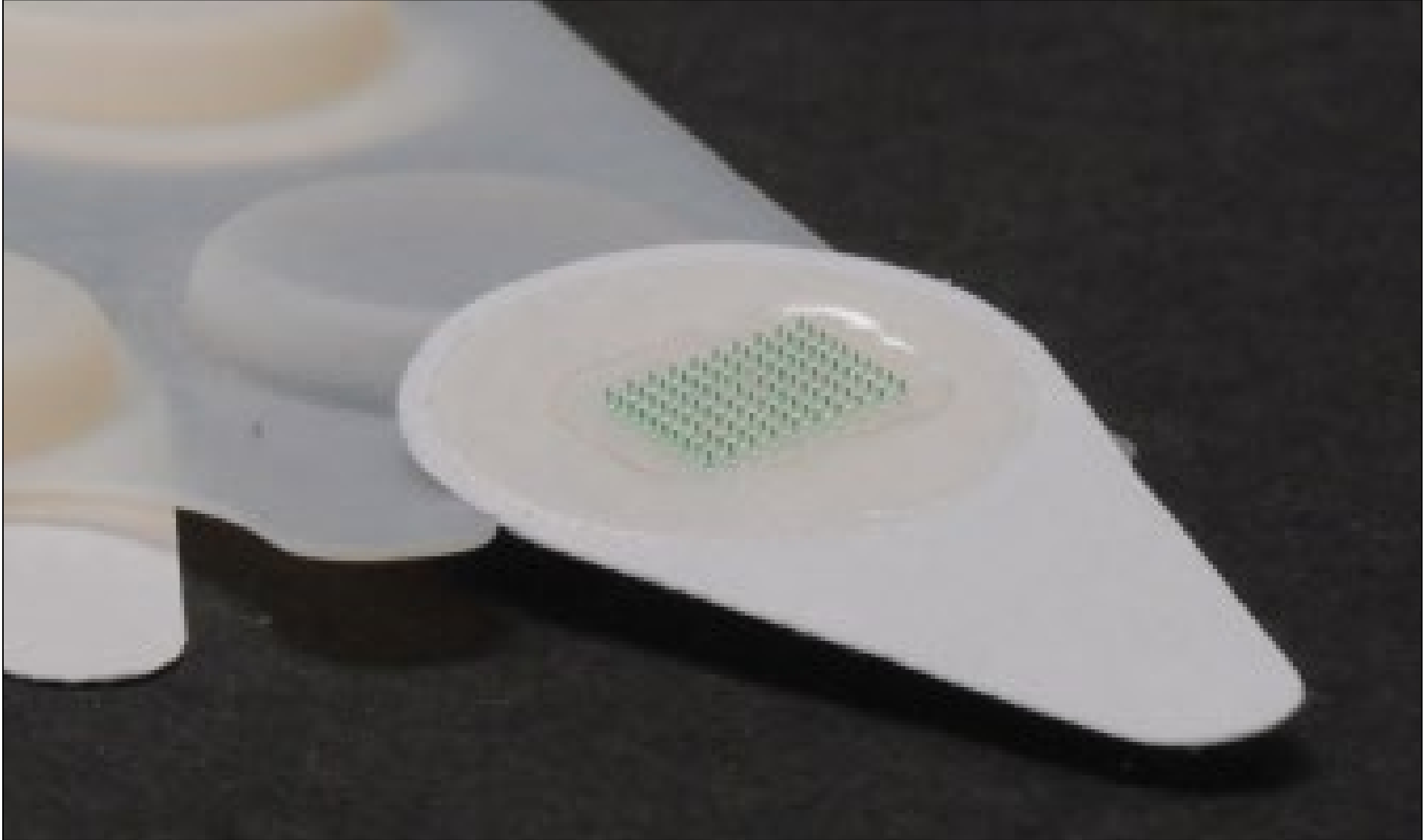
Viable epidermis

Dermis

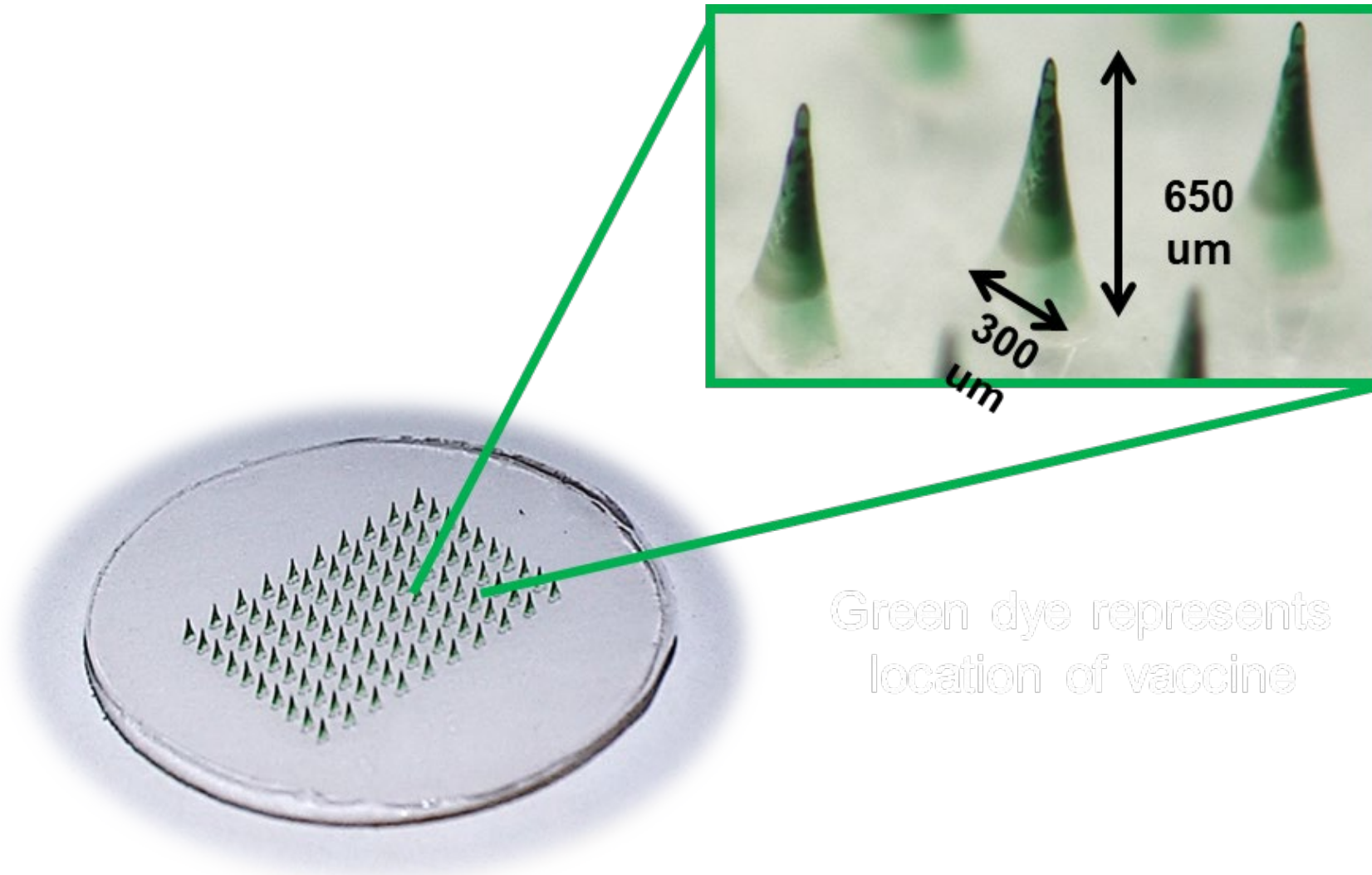
Microneedle patch for vaccination



Microneedle patch for vaccination



Microneedle patch for vaccination



Green dye represents
location of vaccine

Microneedle patch meets public health needs

Patient administration

- Minimally-trained personnel
- No applicator, no reconstitution
- Painless delivery, no fear of needle

Manufacturing

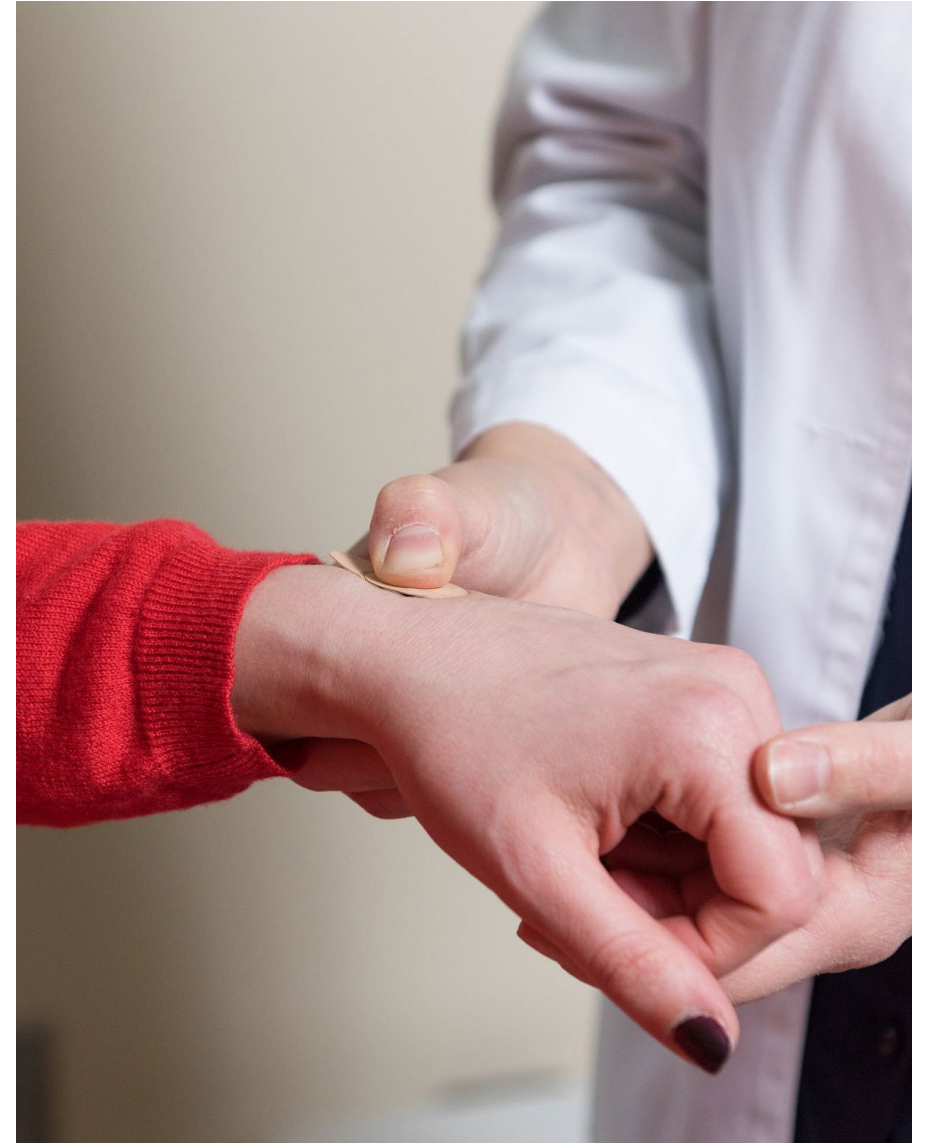
Low-cost, scalable fabrication

Transportation and storage

- Small package size
- Improved thermostability

Waste disposal

- No sharps waste
- Impossible reuse
- Reduced disposal volume



Develop microneedle patches for nanoparticulate vaccines

Human papillomavirus (HPV) vaccine

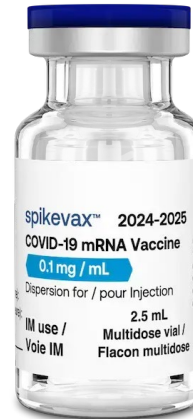
Virus-like particle



Xiamen Innovax Biotech

COVID-19 mRNA-LNP vaccine

Lipid nanoparticle



Moderna

Measles and rubella vaccine

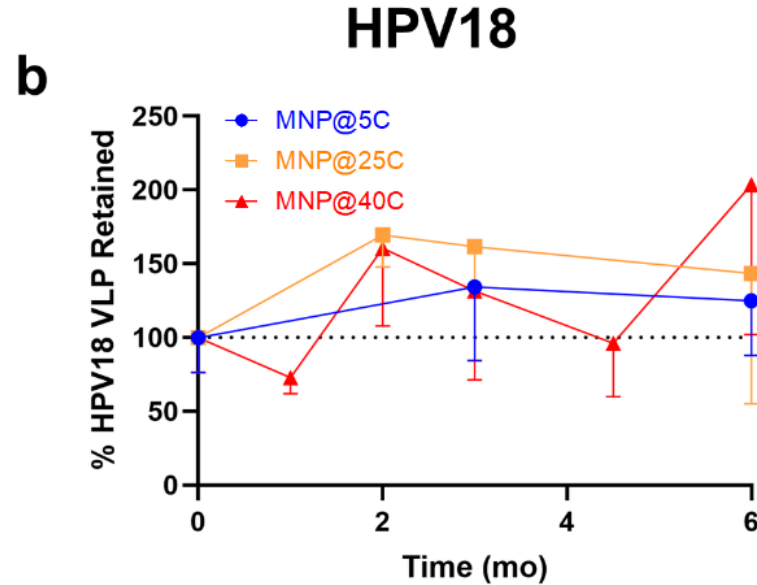
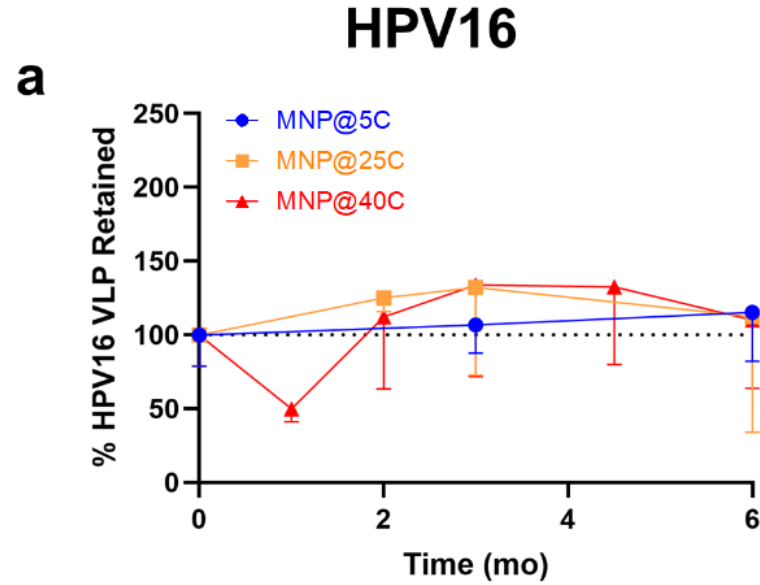
Live attenuated virus



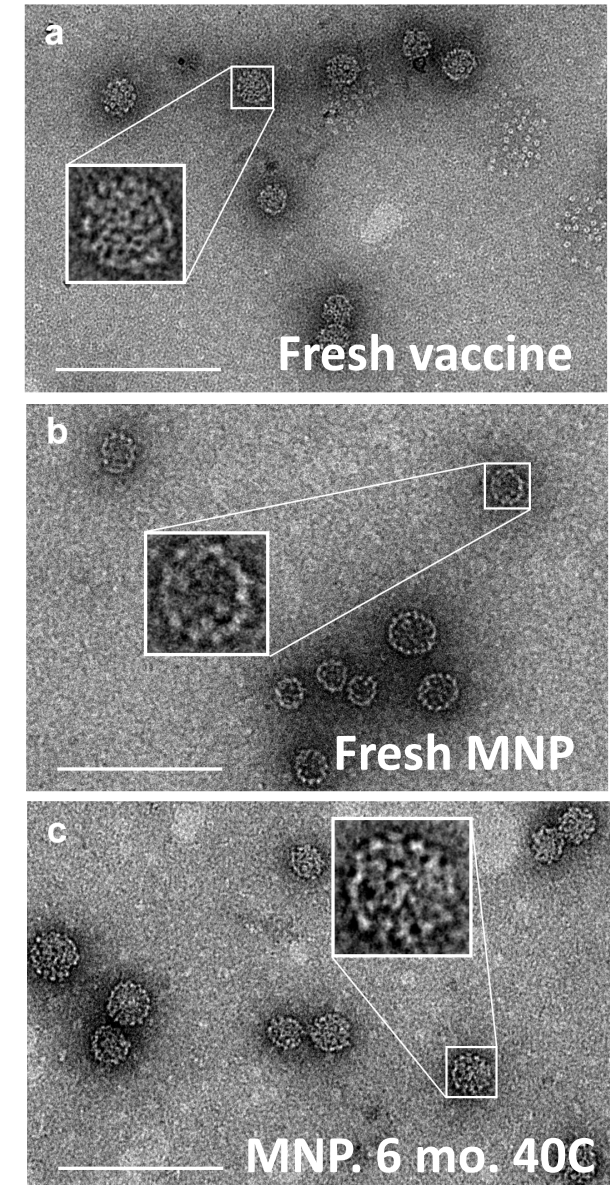
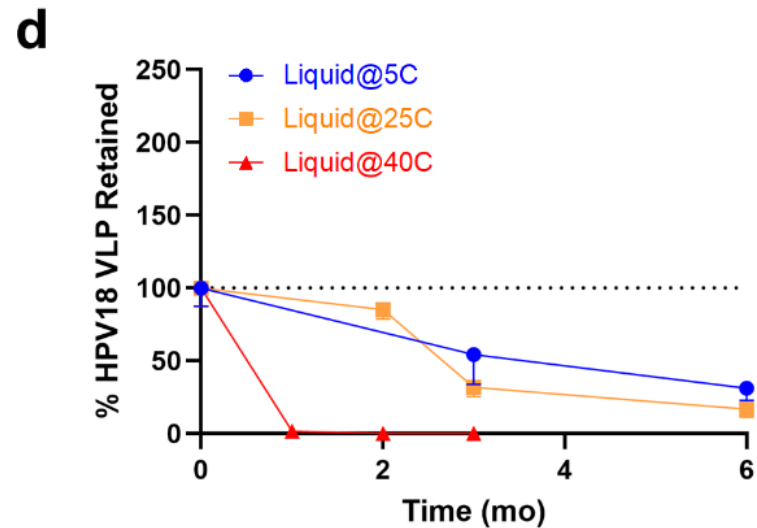
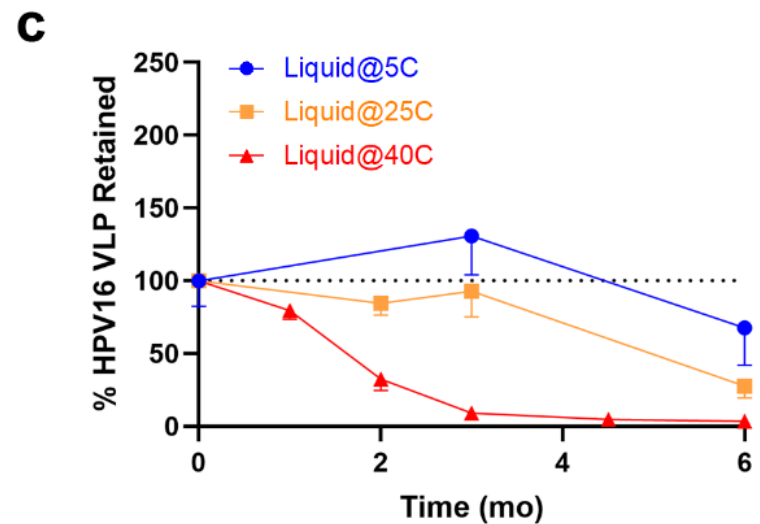
Serum Institute of India

MNP for bivalent HPV vaccination: thermostability

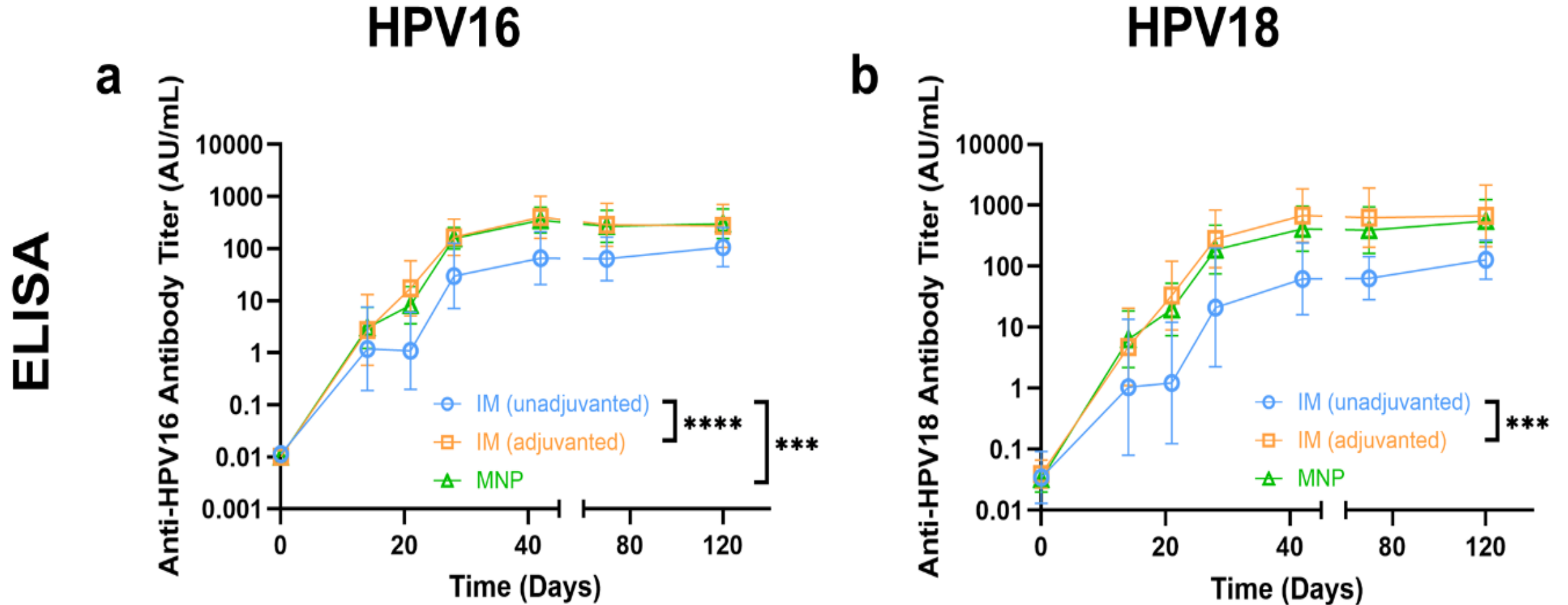
MNP



Liquid Control

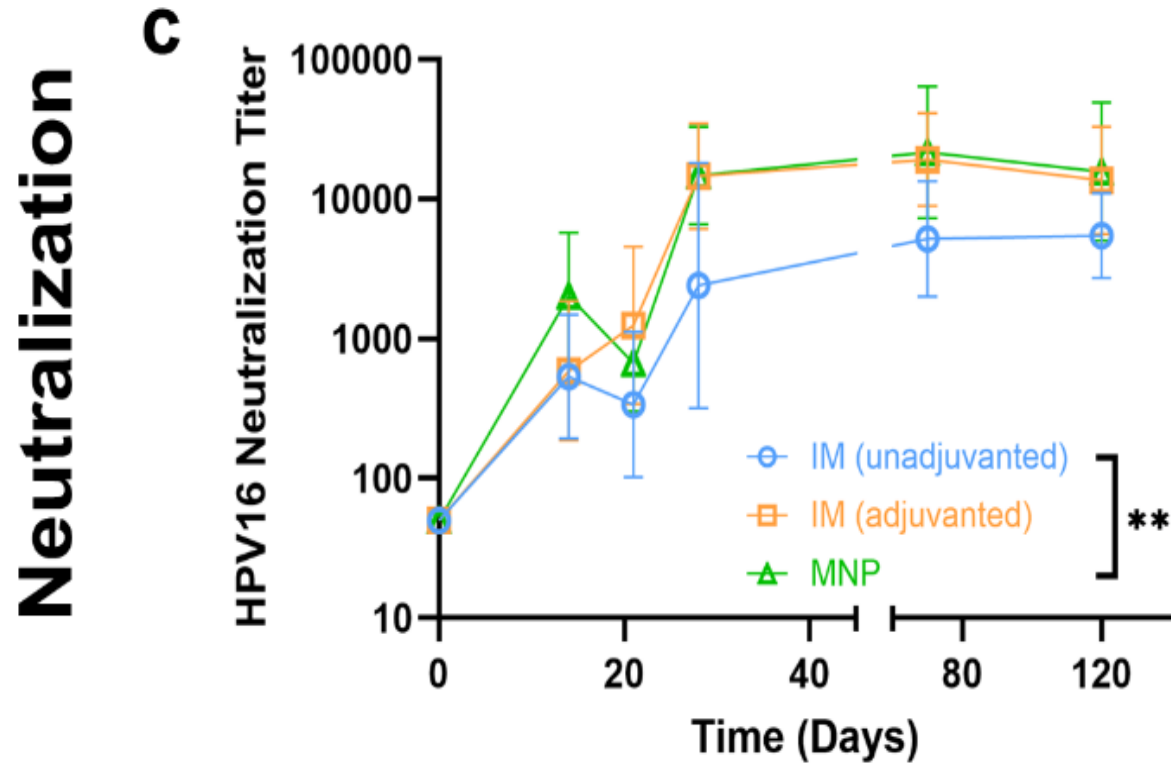


MNP for bivalent HPV vaccination: immunogenicity

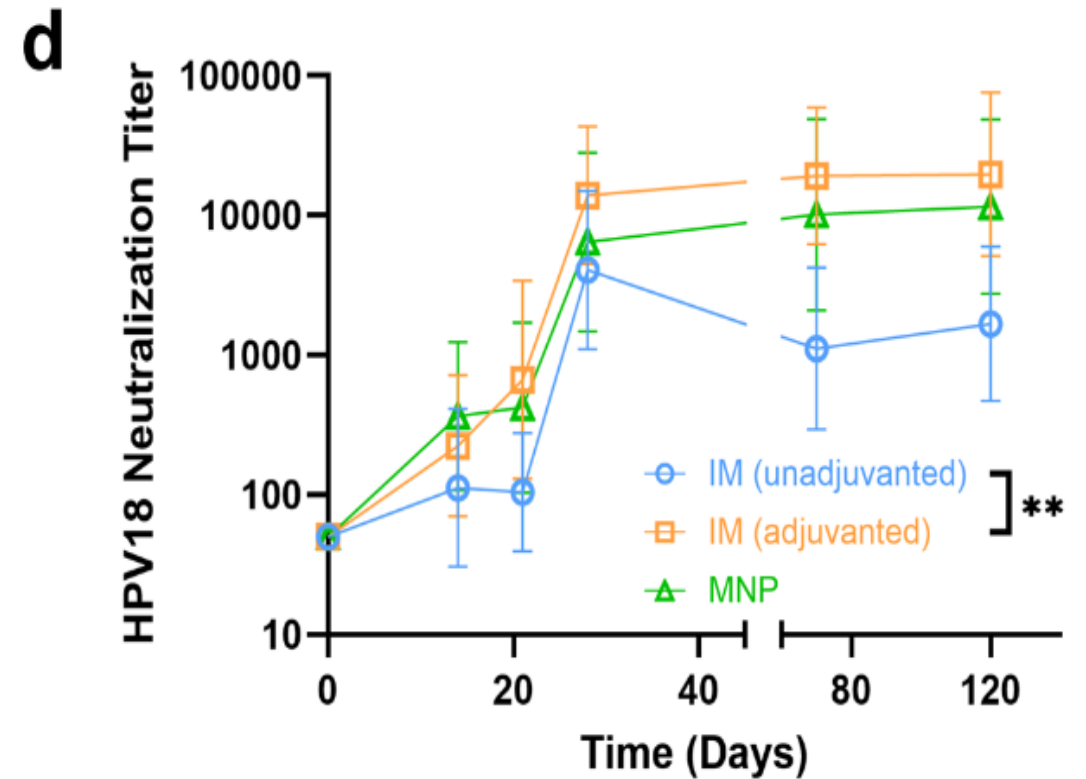


MNP for bivalent HPV vaccination: immunogenicity

HPV16



HPV18



Develop microneedle patches for nanoparticulate vaccines

Human papillomavirus (HPV) vaccine

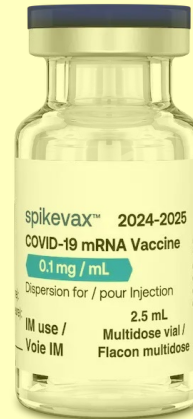
Virus-like particle



Xiamen Innovax Biotech

COVID-19 mRNA-LNP vaccine

Lipid nanoparticle



Moderna

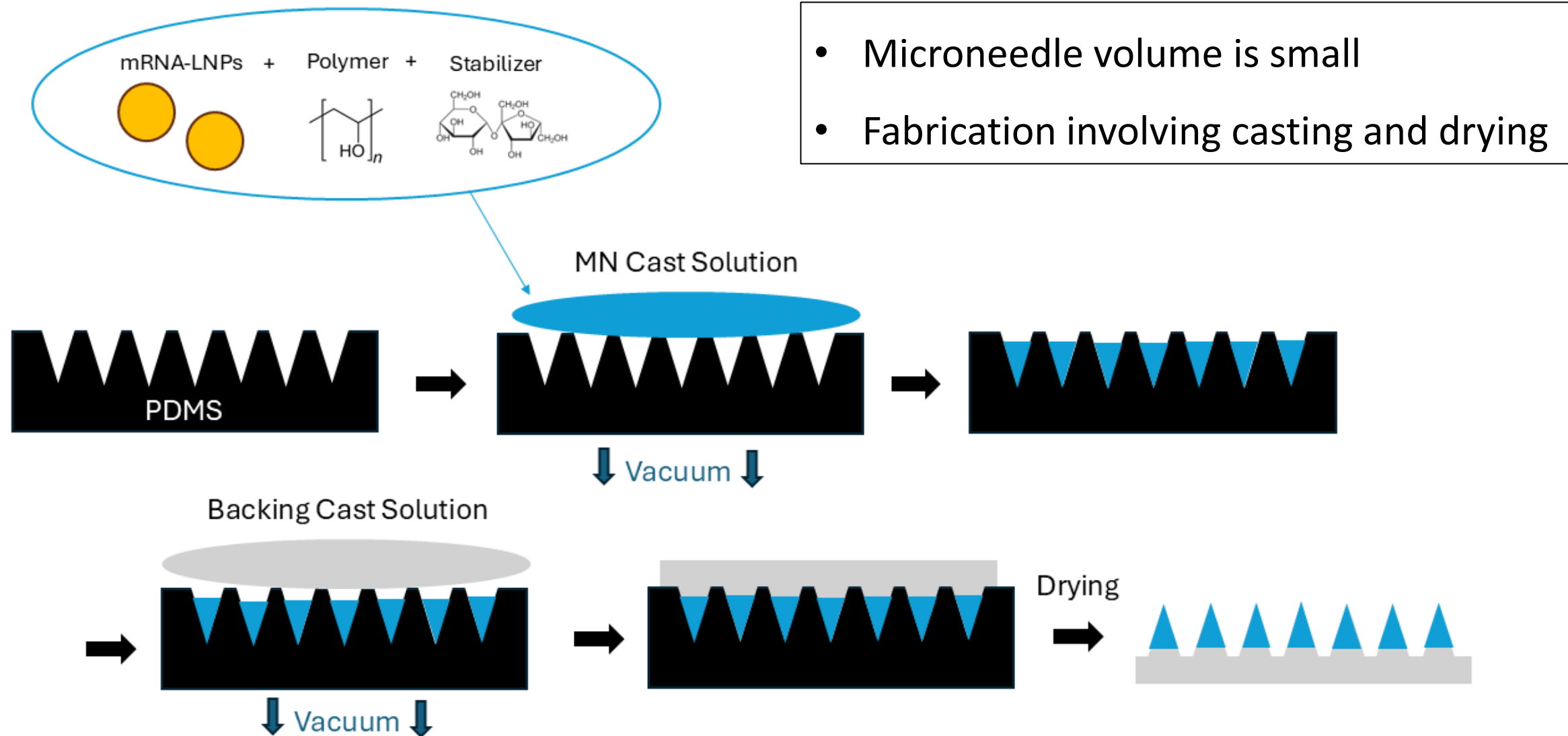
Measles and rubella vaccine

Live attenuated virus

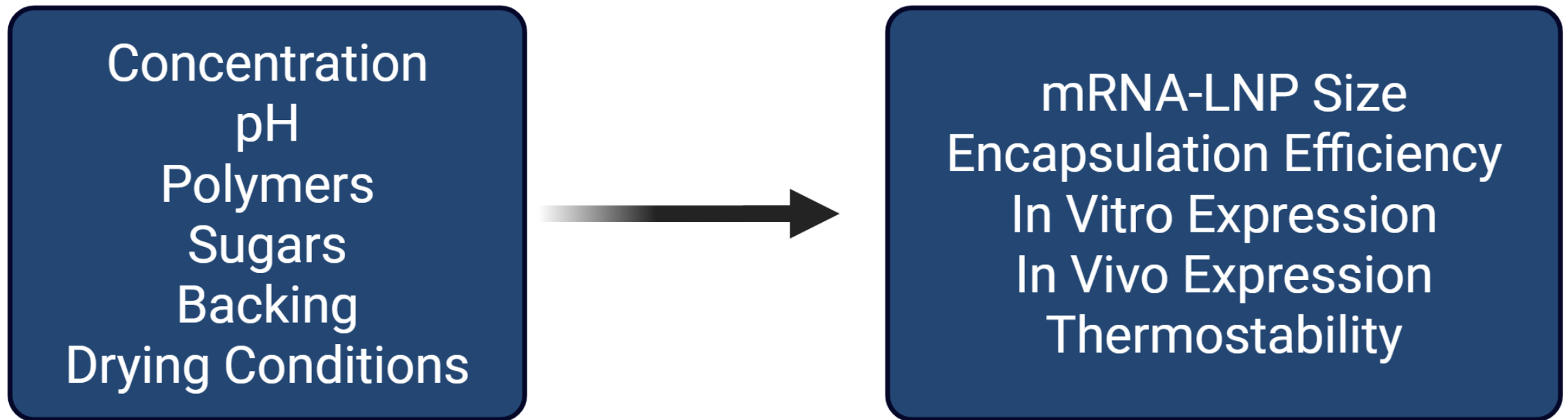


Serum Institute of India

MNP for SARS-CoV-2 vaccination: fabrication process

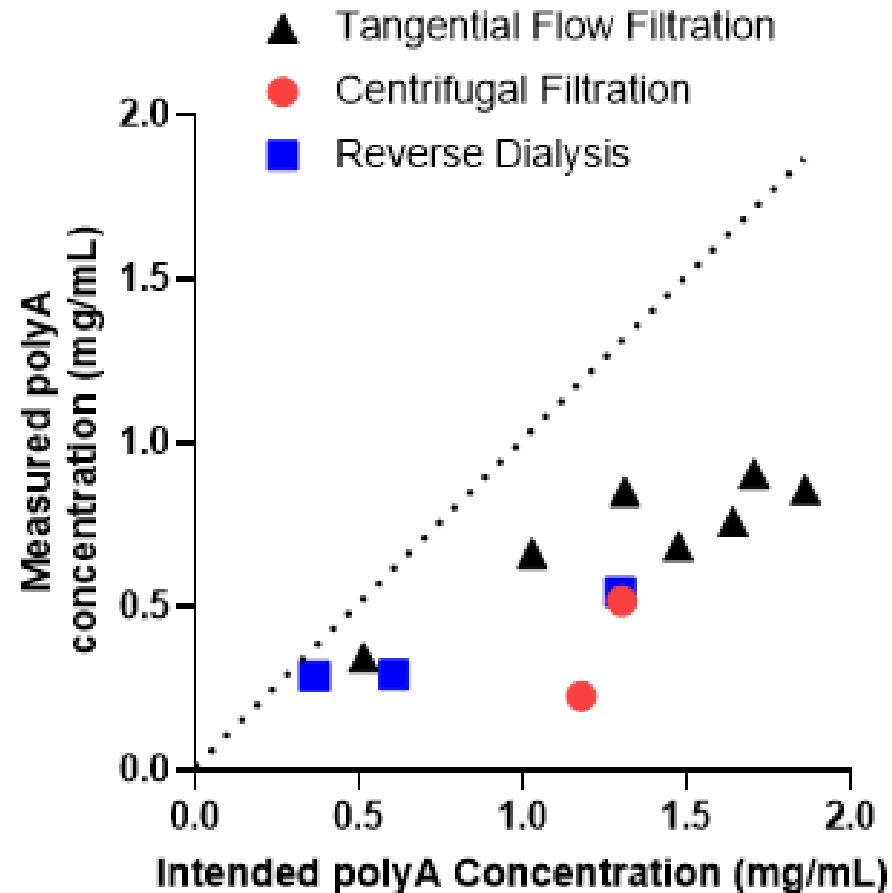


MNP for SARS-CoV-2 vaccination: study design

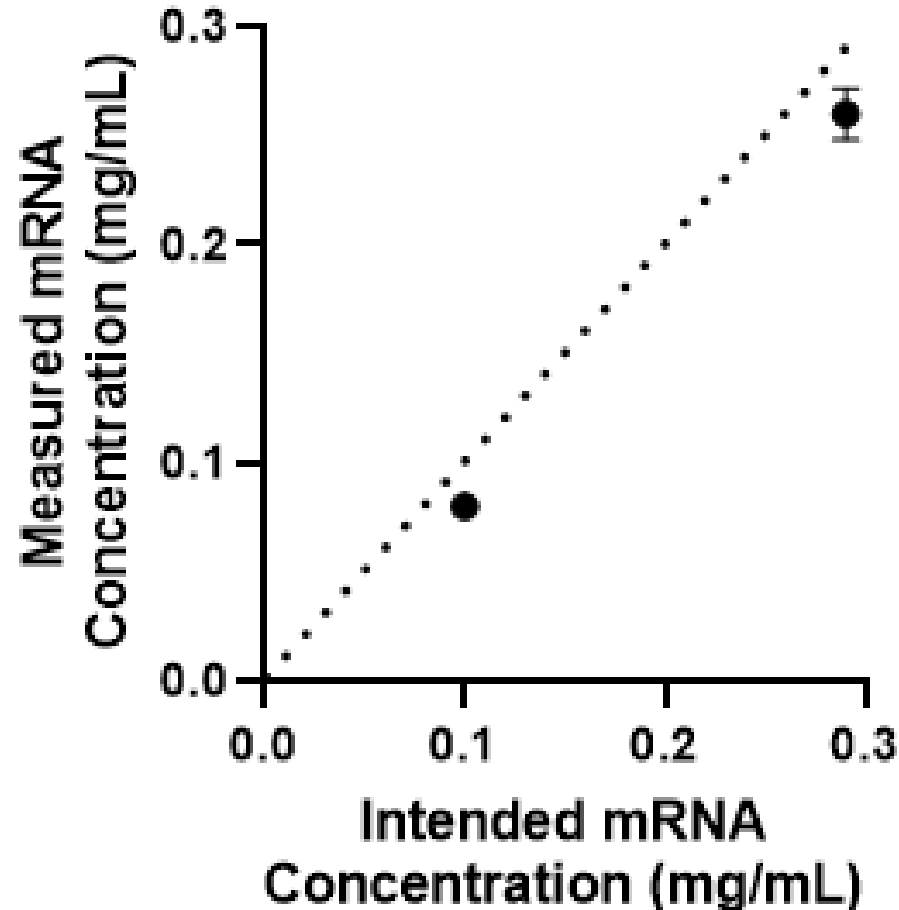


MNP for SARS-CoV-2 vaccination: concentrate mRNA-LNPs

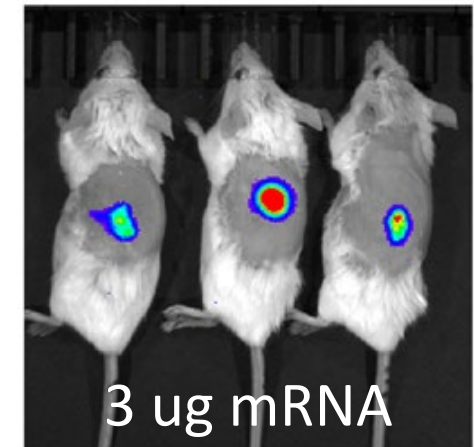
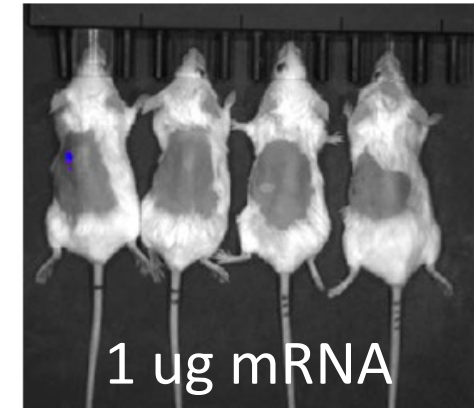
Concentrate post-fabrication



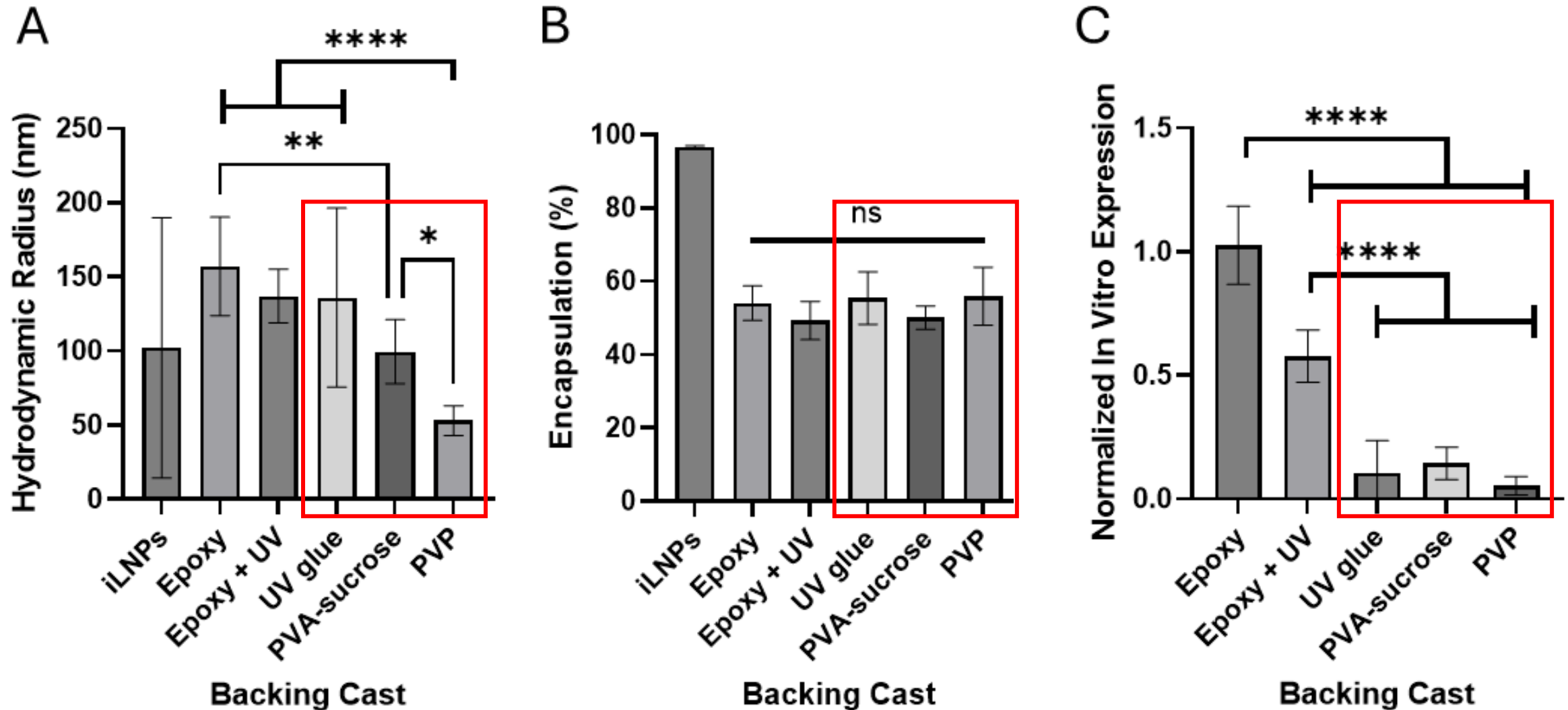
Concentrate pre-fabrication



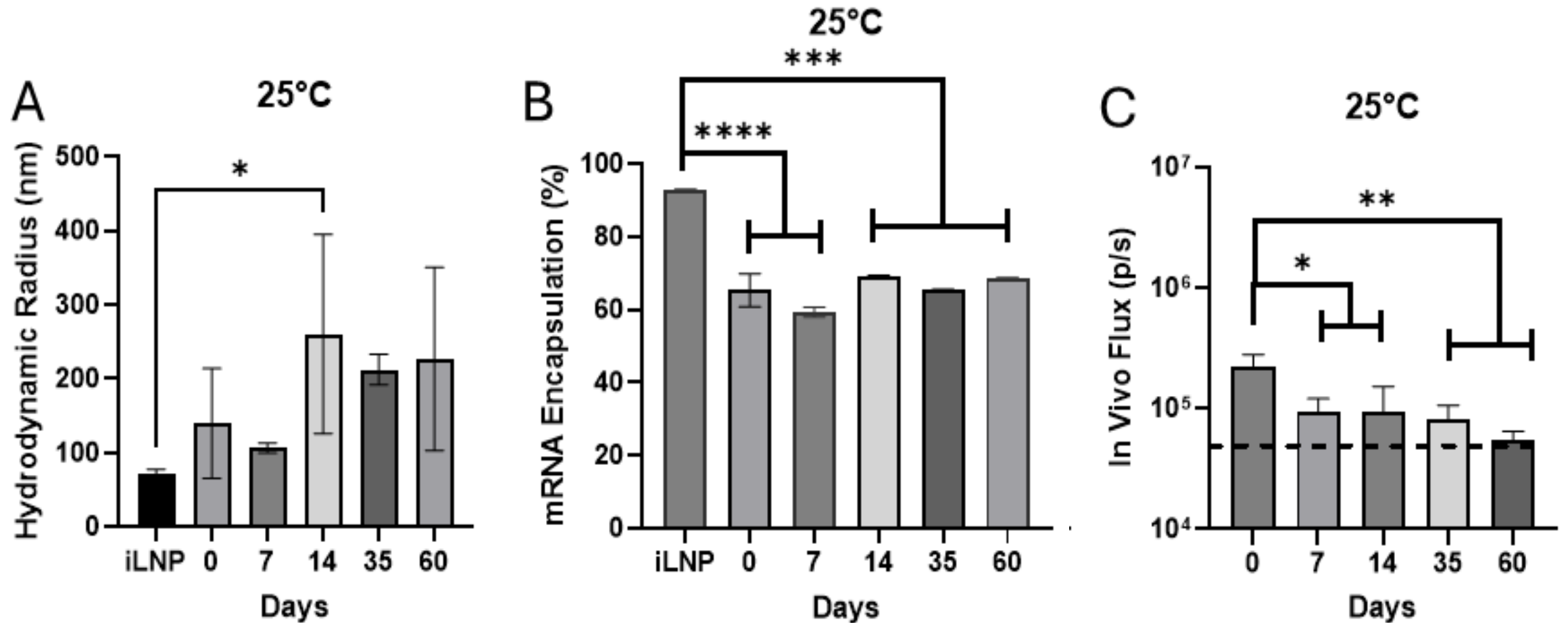
In vivo expression



MNP for SARS-CoV-2 vaccination: MNP backing material



MNP for SARS-CoV-2 vaccination: mRNA-LNP thermostability



Develop microneedle patches for nanoparticulate vaccines

Human papillomavirus (HPV) vaccine

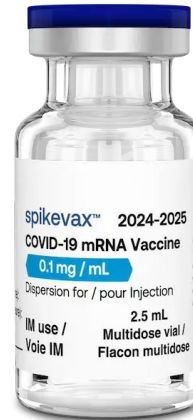
Virus-like particle



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Live attenuated virus



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Phase 1/2 clinical trial of measles/rubella vaccination by MNP



Clinical trial design

Phase 1/2

Randomized

Active-controlled

Double-blind

Double-dummy

Age de-escalation

- 18-40 years old (45 subjects)
- 15-18 months old (120 subjects)
- 9-10 months old (120 subjects)

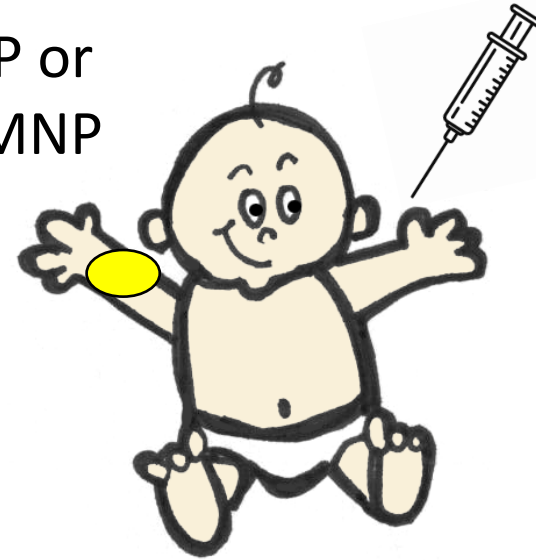
Local and systemic AEs (14 days)

Safety labs (day 7)

Unsolicited AEs (180 days)

Serum neutralizing antibodies (42 and 180 days)

MRV-MNP or
Placebo-MNP

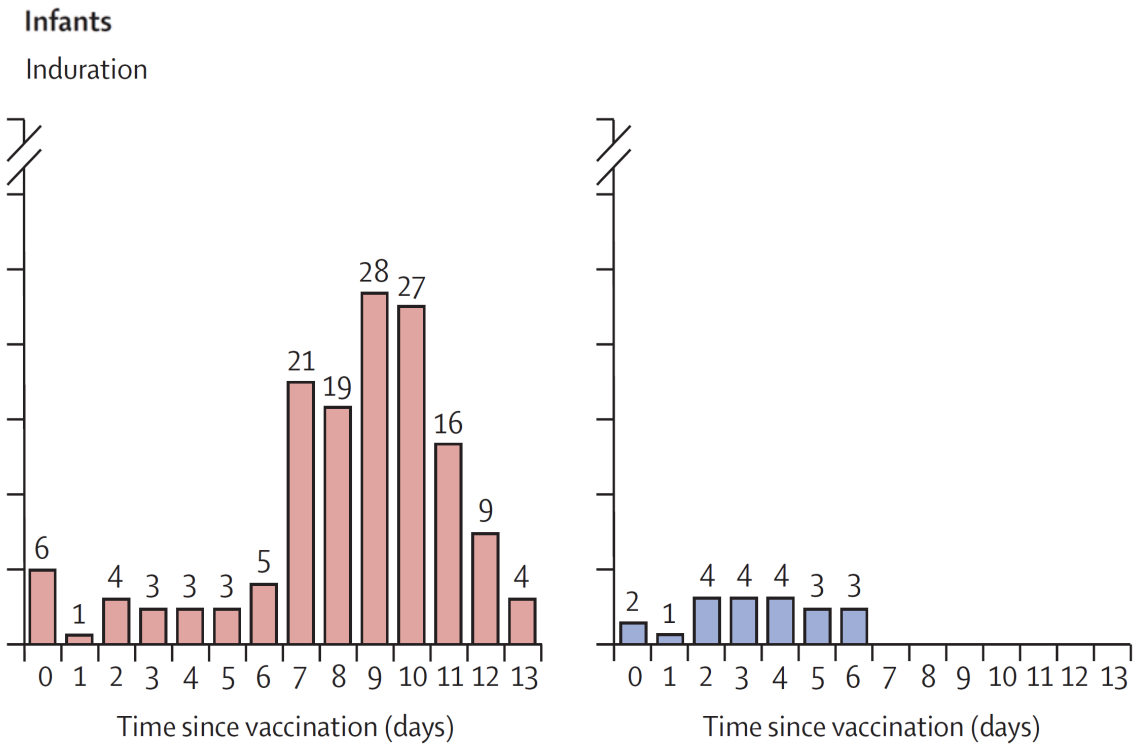
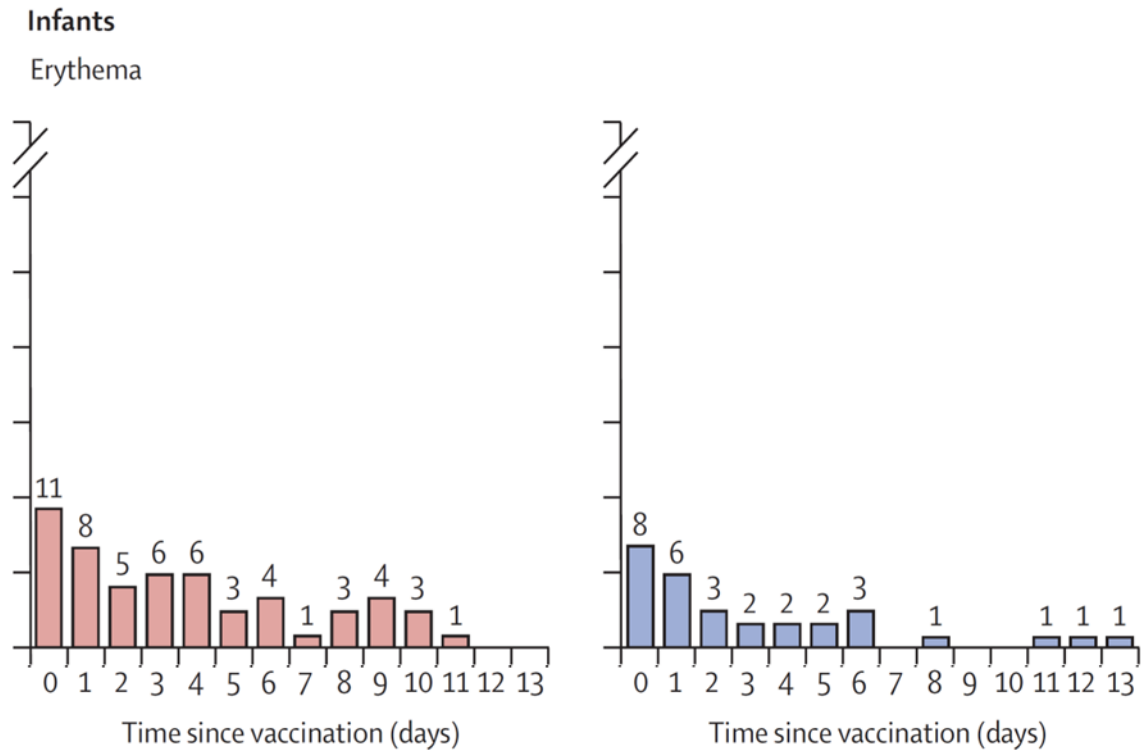


Placebo-SC or
MRV-SC

Measles/rubella vaccination by MNP was well-tolerated

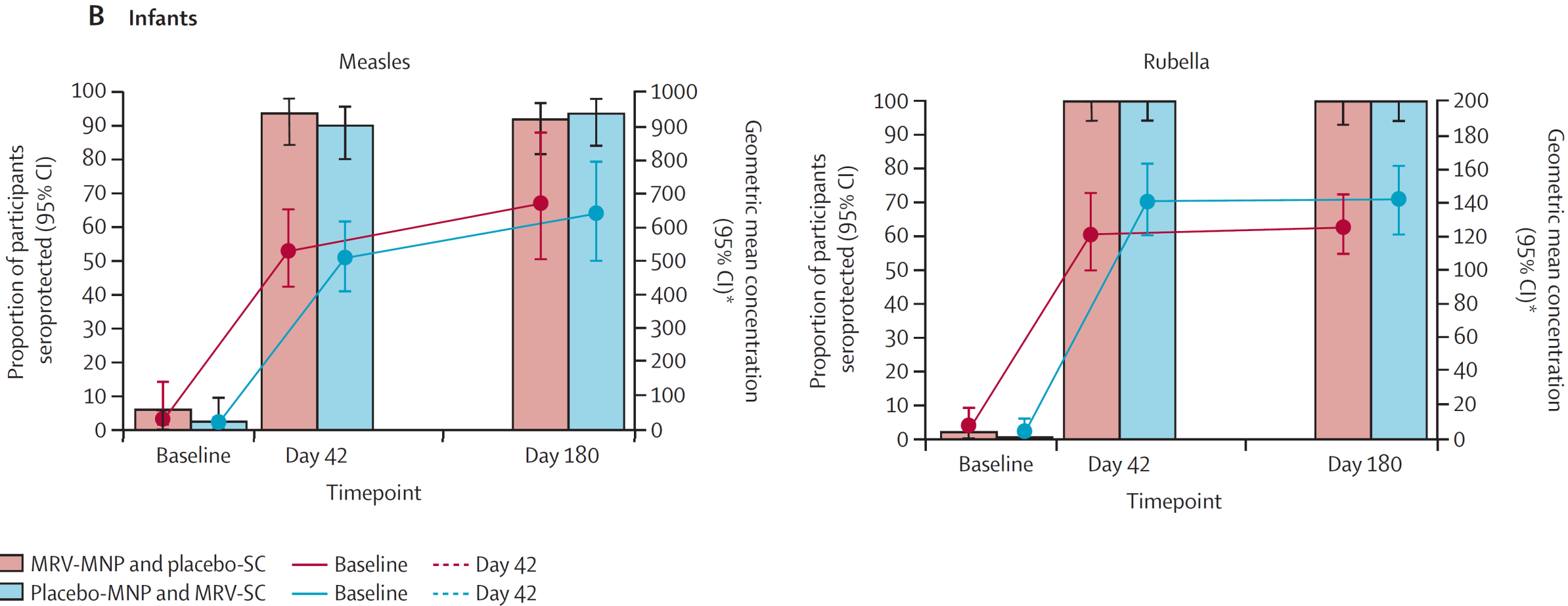
Erythema

Induration



Measles/rubella vaccination by MNP was immunogenic

Serum neutralizing antibody protection levels and mean antibody titers



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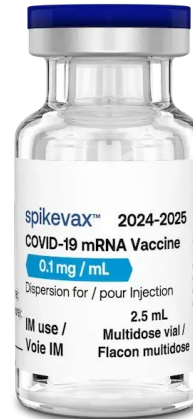
Virus-like particle



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Live attenuated virus



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Acknowledgements



Acknowledgements



GEORGIA
RESEARCH
ALLIANCE



THE **TASK
FORCE**
FOR GLOBAL HEALTH



A close-up photograph of a surface covered with numerous small, red, pointed structures. These structures are arranged in a regular, grid-like pattern. Each structure has a clear, glass-like base and a sharp, red, conical tip. The background is a blurred, reddish-brown color, suggesting a continuation of the same surface.

Questions?