

Technology overview of microarray patches

Webinar for Treatment Action Group
May 31, 2024

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<https://www.path.org/programs/mdht/mapresources/>





PATH is a global team of innovators working to eliminate health inequities so people, communities, and economies can thrive.

A photograph of two scientists in a laboratory. The scientist on the left is wearing a white lab coat, a blue surgical mask, safety glasses, and blue gloves. They are holding a clear plastic bottle with a red cap up to the light. The scientist on the right is also wearing a white lab coat, a blue surgical mask, and safety glasses. The background is filled with laboratory equipment, including shelves with bottles, pipettes, and other labware.

PATH'S MISSION

Advance health
equity through
innovation and
partnerships.

One PATH, one mission, many experts

More than 1,500 strong, our global team includes experts and thought leaders from dozens of specialties including:

- **Product development**—contraceptives, rapid diagnostics, and other devices.
- **Primary health care**—people-centered health systems strengthening.
- **Vaccines and essential medicines**—development, formulation, manufacturing, and rollout.
- **Digital transformation**—electronic immunization registries and other real-time systems.
- **Epidemic preparedness and response**—disease surveillance, responder training, and coordination.
- **Advocacy and communications**—elevating community priorities, influencing local and global stakeholders.



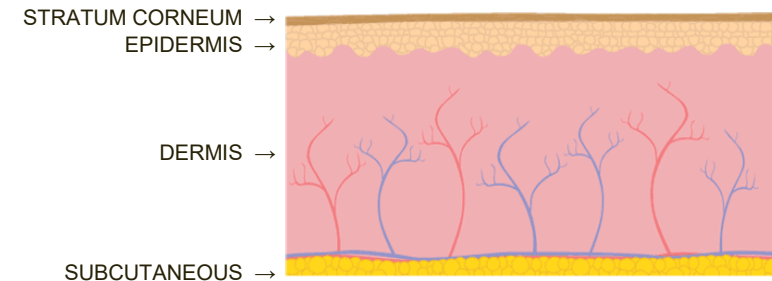
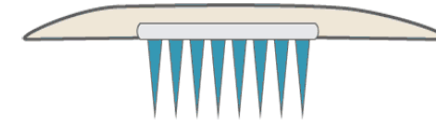
Packaging and delivery technologies at PATH

We identify, advance, and assess primary packaging and delivery devices for vaccines and essential medicines that have the potential to maximize safety and efficacy, expand equitable access, and minimize costs.



Microarray patch (MAP) technology overview

- A patch may have **hundreds or thousands of tiny projections**.
- The projections can be **coated with or composed of a drug and excipients** (dry formulation).
- **The patch is applied to the skin and pressed down** so that the projections penetrate the top of the skin. The patch is worn for a few minutes during which the drug releases into the skin, and then the patch can be removed.
- The projections only **penetrate the top layers of the skin** to deliver the drug.
- It is typically perceived as **less painful than an injection**.
- Some platforms require an **applicator** for delivery (integrated or separate).



Micron MAP (example of simple feedback indicator)



Zosano MAP (example of applicator device)

MAPs could increase access to vaccination and essential medicines in low-resource settings



Attributes

- Ease of use
- No reconstitution
- No needles or sharps waste
- No ancillary supplies
- Enhanced thermostability
- Single-dose presentation



Potential benefits

- Improved acceptability
- Allows for delivery by lesser-trained health workers or self-administration
- Enables new delivery scenarios (house-to-house campaigns, self-administered)
- Reduces vaccine wastage
- Avoid first-pass metabolism



Potential impact

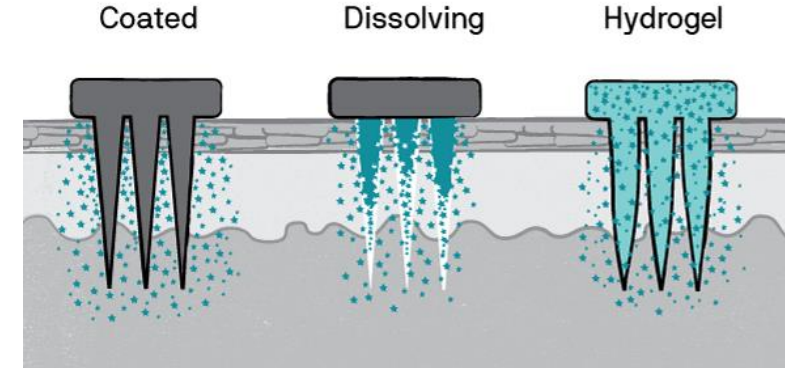
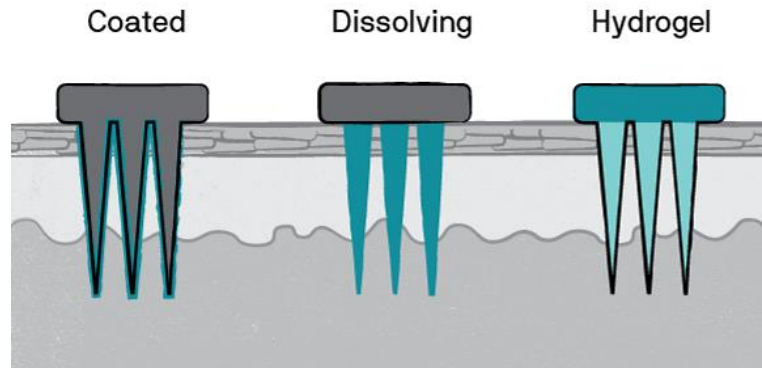
- Increased access and equity

Types of microneedles

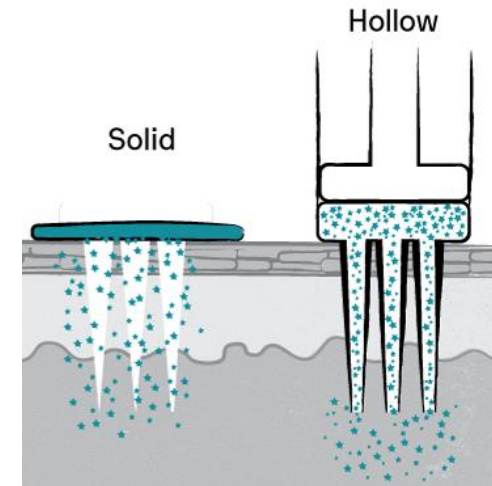
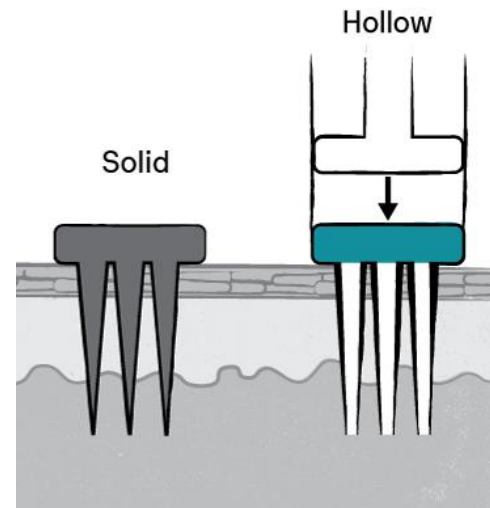
Step one: Microprojections are applied.

Step two: Pharmaceutical is released.

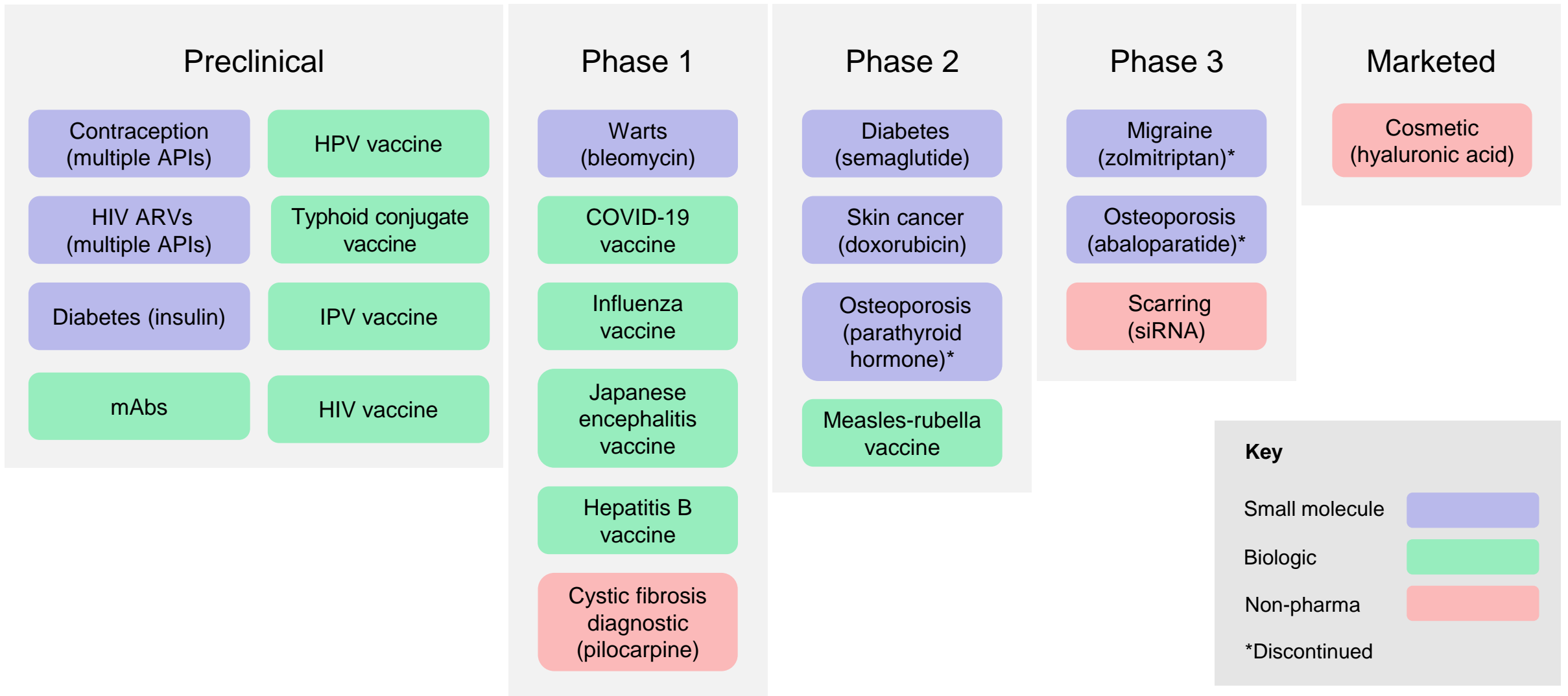
Microarray patches (MAPs)



Liquid delivery via microneedles



MAP landscape: Examples by development phase



First clinical proof of concept of vaccine MAPs in infants



Photo: Micron Biomedical.

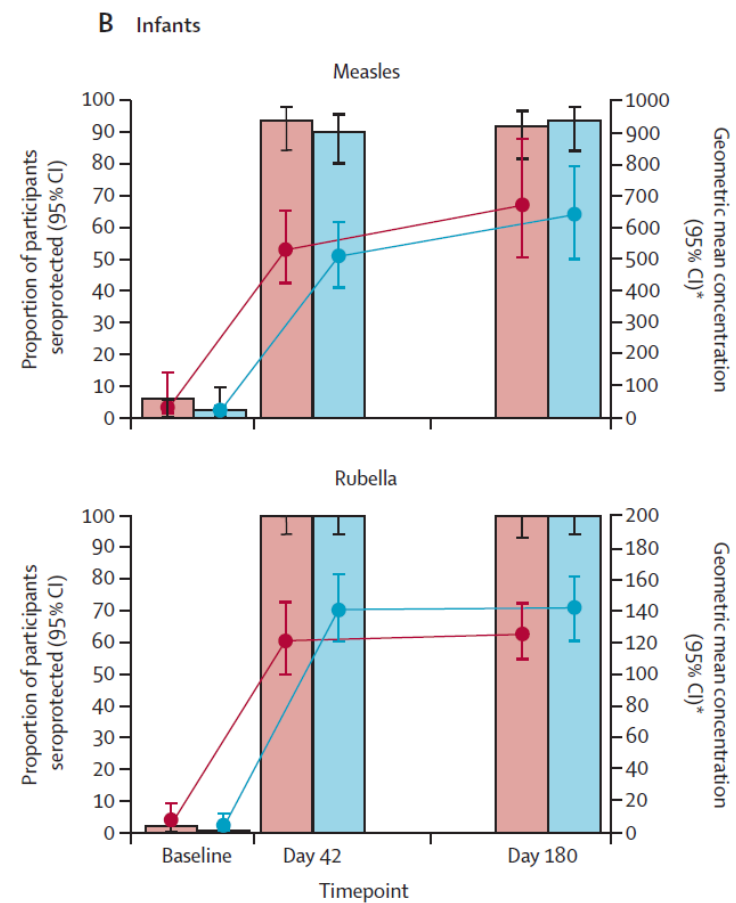
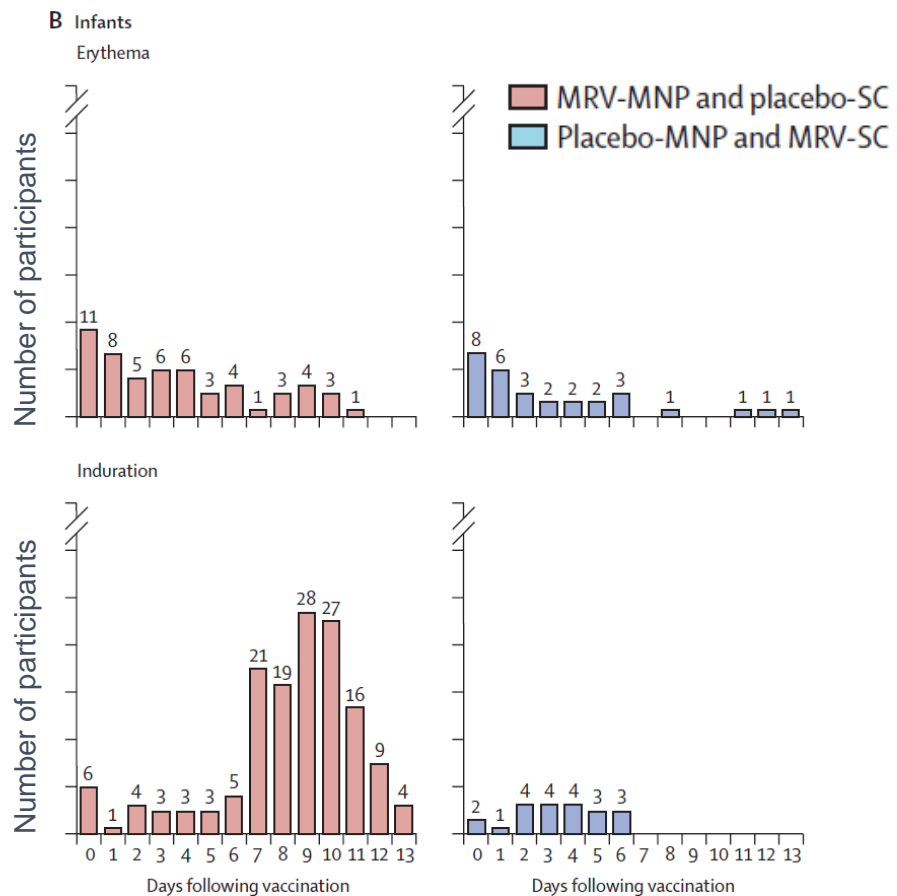
Micron Biomedical announces positive measles and rubella vaccination results from first clinical trial of microarray injection-free vaccine delivery in children.

- **First completed Phase 1 & 2 clinical trial in unprimed 9-month-olds with a microarray patch (MAP) for measles-rubella (MR) vaccine** in 2021–2022 in The Gambia, a country where measles is endemic.
- **Double-blind, double-dummy design** where participants received either an MR MAP and placebo subcutaneous (SC) injection or a placebo MAP and MR SC injection.
- **Vaccination by MAP was safe and well tolerated**, with no allergic reactions or related serious adverse events.
- **Over 90% of the parents of toddlers and infants** enrolled in the trial, who took part in an acceptability survey, said the **MAP technology would be better than SC injection**.

Measles-rubella vaccine MAPs were safe and effective in infants

Mild skin reactions such as induration and discoloration, seen in the active MAP group, all resolved during the study.

High and similar seroprotection and seroconversion rates for MR were shown in all cohorts for both the MAP and SC injection.



Preclinical development of MAP for HIV prevention and treatment

PATH has evaluated MAPs for **long-acting antiretroviral delivery** for adult pre-exposure prophylaxis (PrEP) and pediatric treatment.

User/stakeholder studies in Kenya, South Africa, and Uganda showed **high acceptability of MAP prototype designs for HIV PrEP**. Most potential users preferred the smallest-sized MAP and protection ranging from 1 to 3 months.

For **pediatric HIV treatment**, global, US, and Ugandan HIV experts preferred monthly or weekly MAPs over daily oral treatment.

Our preclinical rat studies and physiologically based pharmacokinetic modeling has indicated that **highly potent antiretroviral drugs are required** to balance dosing frequency and size of MAP.

MAP for HIV PrEP is on hold until a more potent ARV is available for development.

Antiretroviral drug	Adult PrEP	Pediatric treatment
Cabotegravir	Monthly: Not feasible	Weekly schedule for postnatal prophylaxis
Rilpivirine	Monthly: Not feasible	Weekly or monthly: Not feasible
Islatravir	Every 3 months: Feasible, if islatravir developed for PrEP	Monthly schedule for young children is feasible
Lenacapavir	Every 3 months: Not feasible	TBD with oral loading dose

In collaboration with Queen's University Belfast, US Centers for Disease Control and Prevention, and Pharmethus.

Gachigua SG, Karuga R, Ngunjiri A, et al. Microarray patch for HIV prevention and as a multipurpose prevention technology to prevent HIV and unplanned pregnancy: an assessment of potential acceptability, usability, and programmatic fit in Kenya. *Frontiers in Reproductive Health*. 2023;5:1125159.

Ismail A, Magni S, Katahoire A, et al. Exploring user and stakeholder perspectives from South Africa and Uganda to refine microarray patch development for HIV PrEP delivery and as a multipurpose prevention technology. *PLOS One*. 2023;18(8):e0290568.

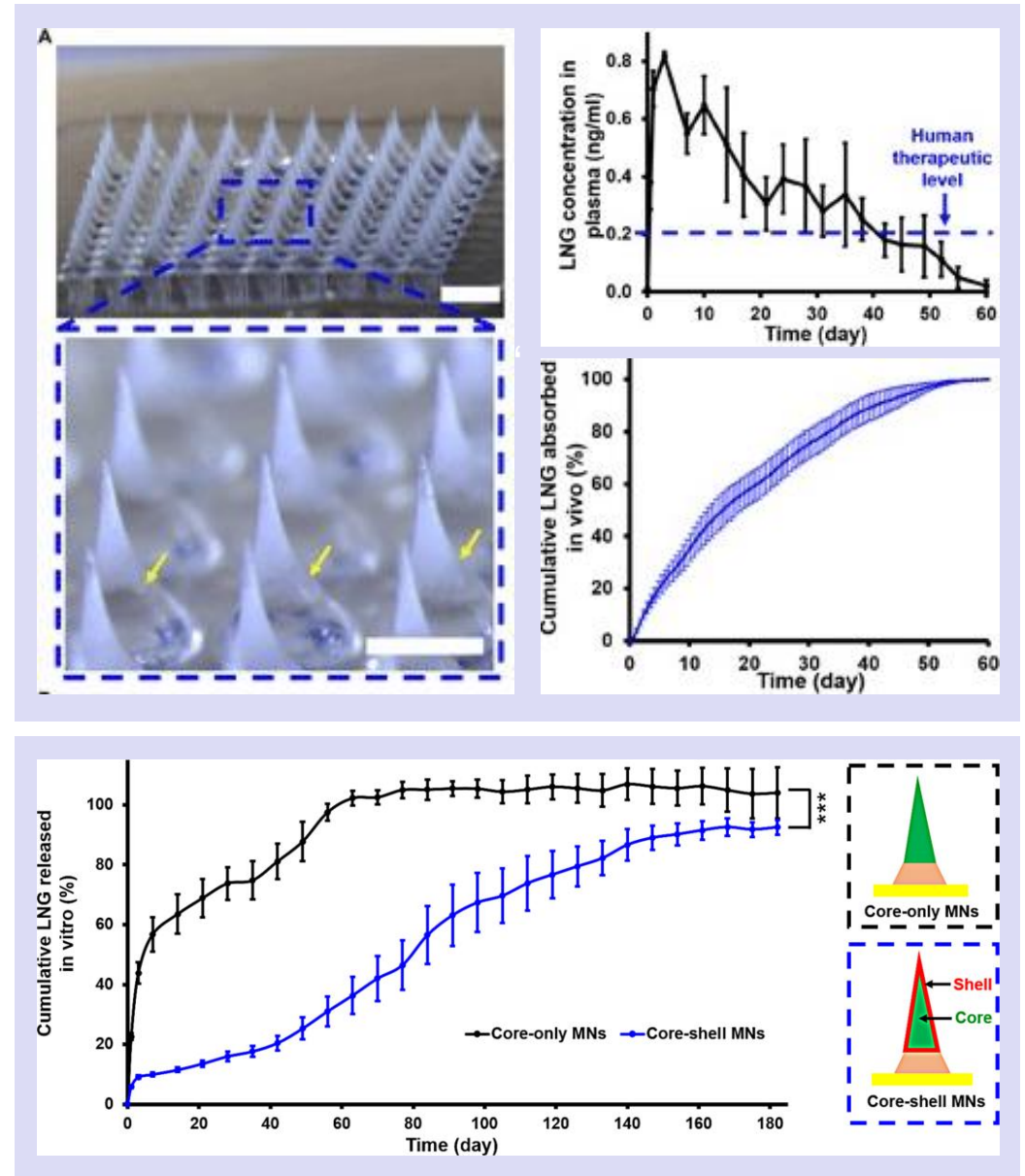
Preclinical development of contraceptive MAPs

Several organizations have published findings on developing MAPs to deliver **hormonal contraceptive**—levonorgestrel.

Data in preclinical models indicate that MAPs could need to be applied **monthly, every 2 months, or even every 6 months**.

Based on the design of the MAP, the **wear time** can range from several seconds to several minutes.

Developers are working on designs that can be **self-administered**, providing women with an option for long-acting, user-controlled contraception.



Li W, Chen JY, Terry RN, et al. Core-shell microneedle patch for six-month controlled-release contraceptive delivery. *Journal of Controlled Release*. 2022;347:489-499.

Li W, Tang J, Terry RN, et al. Long-acting reversible contraception by effervescent microneedle patch. *Science Advances*. 2019; 6;5(11):eaaw8145.

Challenges to develop MAPs for treatment and prevention

Manufacturing scale-up

- This novel combination product requires new manufacturing facilities and test methods, leading to high initial investment.
- Benchtop processes need to be scaled up to enable late-stage clinical and commercial production.

Regulatory pathway

- Regulators will need to be consulted on clinical and CMC plans.
- A novel device will require new testing methods, critical quality attributes (CQAs), etc.

Drug amounts needed for treatment and prevention

- MAPs can deliver a limited amount of drug, about 1 mg per cm².
- Treatment and prevention of HIV, tuberculosis, HCV, etc. require higher doses, which limits MAP feasibility.
- There is a need to balance potency of drug, MAP size, and treatment length.

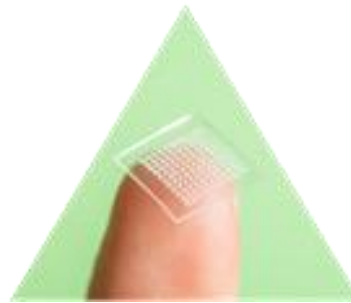
Market feasibility

- Unknown market size and demand for these products. Unknown if the demand will enable sustainable markets for MAP manufacturers.
- MAPs will cost more than a vaccine vial or oral pills. Total cost of delivery may be less, given other attributes of the product.
- Given the higher costs and potential benefits, need to understand the willingness to pay for a MAP.

Introduction and adoption

- Raise awareness among community and decision-makers.
- Understand opportunities and challenges for MAP introduction in LMICs to integrate into the health care system. Understand how self-administration of a MAP could fit into the health systems.
- Clarify value proposition relative to existing products.

Engagement opportunities



Newsletter: Please contact MAPs@path.org to be adding to the mailing list.

MAP Resources page: For more information on PATH's work on microarray patches, go to <https://www.path.org/programs/mdht/mapresources/>.

VIPS site: For more information on the VIPS Alliance and the technologies, go to <https://www.gavi.org/our-alliance/market-shaping/vaccine-innovation-prioritisation-strategy>

Target product profiles: To review and provide input on MAP target product profiles, go to <https://www.path.org/resources/microarray-patch-target-product-profiles-tpp/>.

Regulatory Working Group: Register your interest in the Regulatory Working Group at <http://www.microneedleregulatory.org/>.

For more
information
contact:

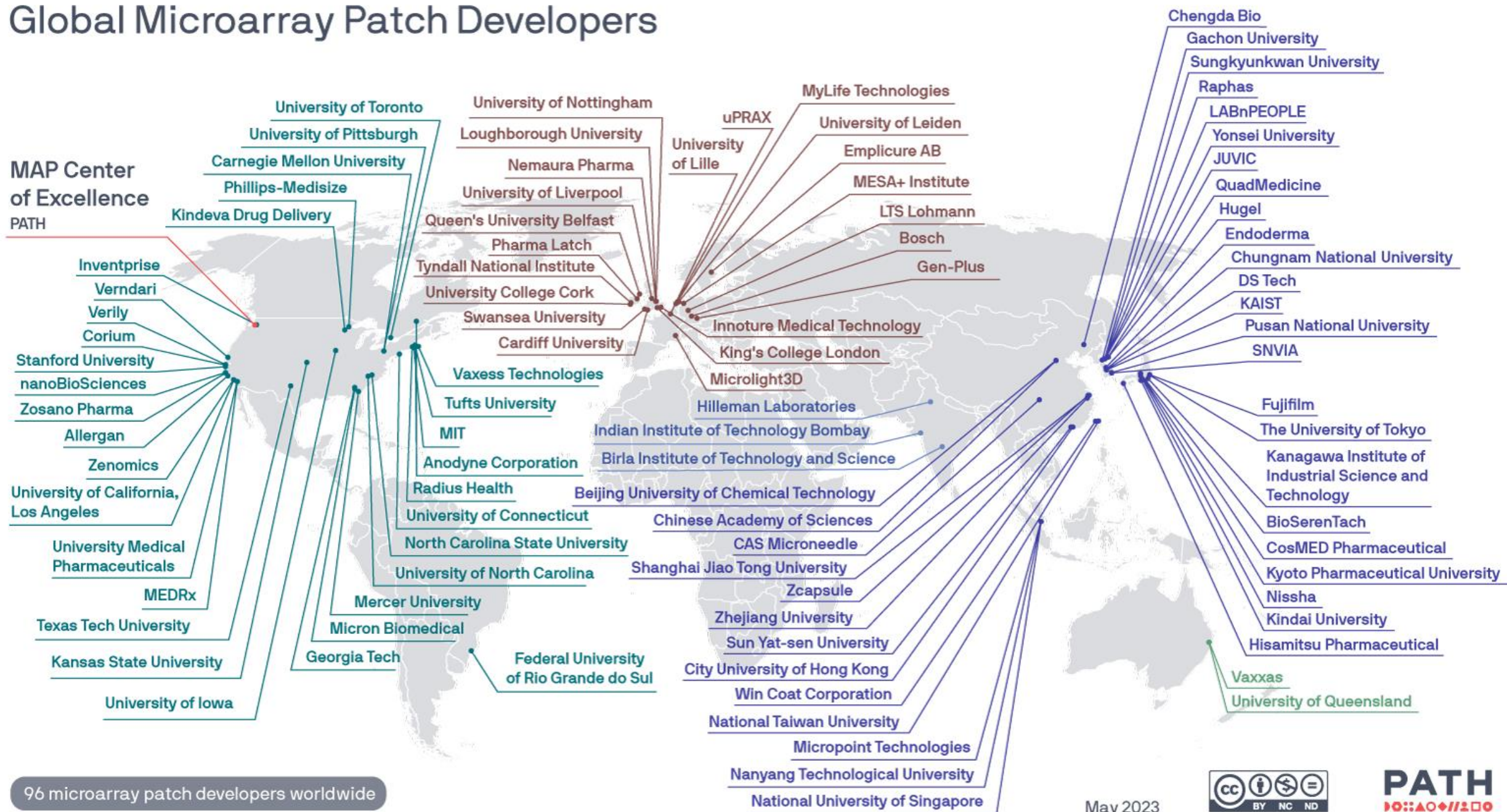
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Appendix

Global Microarray Patch Developers

MAP Center
of Excellence
PATH



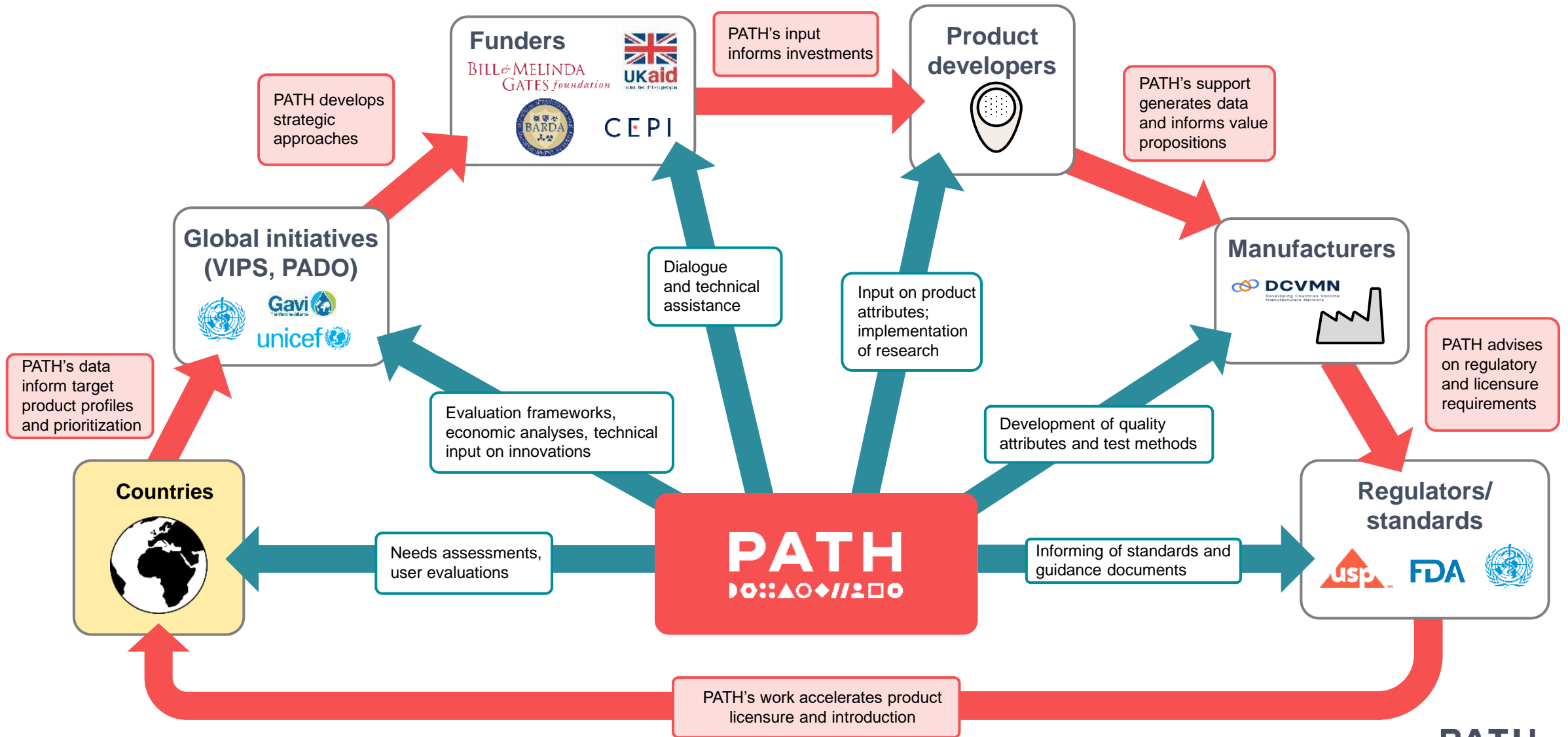
96 microarray patch developers worldwide

May 2023

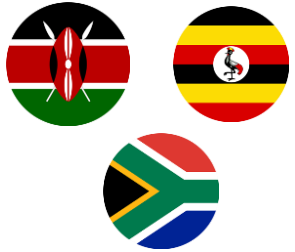


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PATH's role and impact: Microarray patch field



User and stakeholder perspectives used to assess and refine HIV PrEP and MPT MAP prototypes



PATH and country partners implemented iterative user and stakeholder assessments in Kenya, Uganda, and South Africa. Women and men (18–40 years, n = 430 participants) participated in focus group discussions and mock use exercises. Key informant interviews gauged the decision-maker ecosystem for MAPs.

1



Explored user/stakeholder perspectives about MAPs

2



Assessed acceptability, usability, and programmatic fit for HIV PrEP or MPT

3



Explored needs and preferences for **key features** among various audiences



- Size
- Duration of protection
- Application site
- Wear time
- Delivery indicator
- Potential for discreet use
- Other features (packaging, instructions, etc.)
- Cost considerations