

## A SHOT AT A NEW DRUG-DELIVERY SYSTEM

by David Pescovitz

Tomorrow's rural populations may be saved from deadly diseases like malaria, typhoid, and whooping cough with a dose of freeze-dried medicine painlessly pushed directly into the skin by a friend or family member.

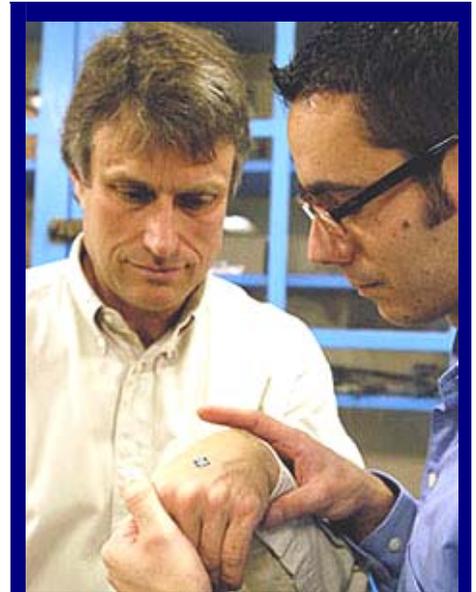
UC Berkeley bioengineering professor Dorian Liepmann and post-doctoral researcher Boris Stoeber have developed a microelectromechanical system (MEMS) syringe, the size of a fingernail. MEMS are fabricated cheaply and in bulk using processes similar to those used in manufacturing integrated circuits. Called a *chiclet* for its resemblance to a square of gum, the MEMS syringe delivers the freeze-dried drug stored inside through up to 100 microneedles. Fortunately, the targeted site in the skin is out of reach of sensitive nerve endings, making the drug delivery completely painless.

According to the World Health Organization, malaria kills more than one million people yearly while seventeen million are hit with typhoid. These and other diseases are tough to contain in developing nations where clean water and medical help are scarce.

"By finding an alternative way to deliver drugs, we can open the door to more effective treatment of life-threatening illness," says Liepmann, who is also a professor in the Department of Mechanical Engineering.

The MEMS syringe is designed to be shipped pre-loaded with a lyophilized, or freeze-dried, drug stored in its silicone rubber reservoir. Keeping the drug in its lyophilized state, Liepmann explains, ensures a long shelf life and negates the need for sterile water or electrically powered refrigerators to cool antibiotics like penicillin that are temperature sensitive once reconstituted.

The "shot" is delivered simply by pressing the device against the skin for a few seconds. The dry drug is pushed through the microneedles and into the skin where the body's own interstitial fluids assist in rapidly absorbing the drug directly into the bloodstream.



Boris Stoeber (right) gently presses the MEMS chiclet on Dorian Liepmann's hand, all it takes to deliver a life-saving dose of antibiotics. Stoeber fabricated the 10 mm x 10 mm MEMS syringe prototype in the Berkeley Microfabrication Lab, a project funded by the Defense Research Projects Agency, and Becton, Dickinson & Company.  
*Peg Skorpinski photo*



This neon-lit, transparent microfluidic device, seen here on an inverted stage microscope, allows Stoeber to visualize the route particles travel as they enter a small channel, much like the microneedle channels in the chiclet-sized syringe.  
*Peg Skorpinski photo*

"The MEMS syringe will be attractive to developed countries too," Stoeber says. "It could make drugs available that have been avoided because taking them orally causes liver and kidney damage. Drugs delivered through the MEMS syringe would bypass the liver, directly entering the bloodstream."

Early stage tests on chicken breast tissues have been successful, and preliminary clinical trials are scheduled for spring at the University of California, San Francisco Medical Center. Someday, the technology could also be used in emergency rooms or in space for astronauts to administer emergency treatments. The fast-and-easy drug delivery system would also be a godsend during a bioterrorist attack when a large number of victims are in need of immediate treatment.

"We've proved the principle," Liepmann says. "Now we have to move on to clinical trials with specific drugs — the final validation of the drug delivery concept."

*Melinda Levine contributed to this story.*

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