

solving lipids in a small reservoir of oil. Water droplets measuring less than a millimeter across join the mix, causing the lipids to form a coating on the droplets of no more than half the thickness of a cell membrane. “These systems are very stable, like a robust soap bubble with a skin that’s a biological surface,” notes Matthew Holden, a postdoctoral fellow at the Oxford laboratory of chemist Hagan Bayley, where much of the research took place [see “Building Doors into Cells,” by Hagan Bayley; *SCIENTIFIC AMERICAN*, September 1997].

Dubbed “liquid Lego,” the droplets are intended to be a test bed for exploring the workings of not just a single cell membrane but an entire network of protocells. When a droplet joins with one of its neighbors, the two form the equivalent of a complete membrane. Ultimately, the team would like to engineer droplets with different characteristics, varying the pH of the water inside a droplet or the types of membrane channels used. Alternatively, different droplets may contain different drugs. The objective is to demonstrate

how cells that constitute heart, brain or lung tissues communicate among themselves. “The new preparation of nanodrops holds enormous promise,” says Bob Eisenberg, chairman of biophysics and physiology at Rush University Medical Center in Chicago. “It will allow manipulation of ion channels in new ways; it will allow systems to be built from arrays of drops that show interesting properties.”

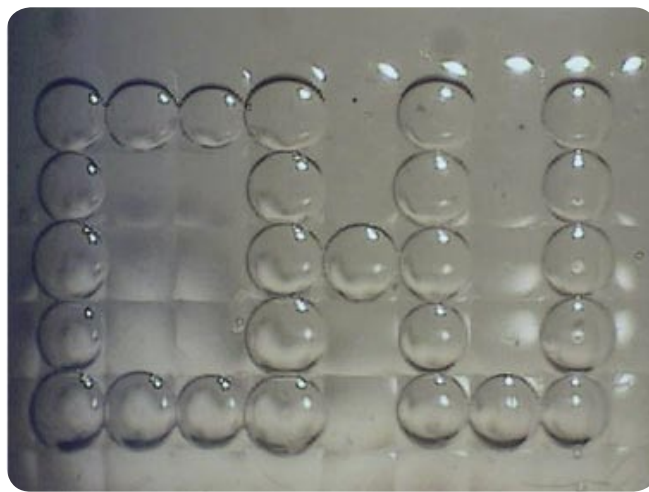
For the moment, simulating the pulsations of a heartbeat on a chip remains a dream, although the necessary tools are

starting to come forth. In the June 16 online *Journal of the American Chemical Society*, Holden and his colleagues recount how they sent current through a chain of 16 droplets by plugging electrodes into various droplets along the network. They inserted bacterial pores (surrogates for ion channels) into the lipid protomembranes and also showed how electrodes could be used to add or remove droplets while keeping the network intact.

Two droplet experiments demonstrated the prospect of one day building autonomous systems that power themselves or make their own components.

The paper describes a battery devised by infusing droplets with differing concentrations of ions and, separately, a current generated when droplets were infused with a membrane protein (bacteriorhodopsin) that causes protons to flow when exposed to green light.

The last unrealized step, of course, would be to insert DNA and organelles from a cell that could encode the desired ion channel from within the droplet. Then all scientists might have to do is just turn on the lights and watch the show.



LIQUID LEGO: Fat-covered droplets snap together to form the initials for the University of Oxford, where these imitation cells, each of which holds 200 nanoliters of water, were first concocted.

HEALTH

Scared Off Silicone

Liability fears trump science for ulcer-beating injectable silicone **BY MELINDA WENNER**

Of the 20 million Americans suffering today from diabetes, one million will probably be killed by their feet. A diabetic foot ulcer and its attendant complications constitute a surer death sentence than colorectal cancer—just over half of all diagnosed patients survive for five years. More startling than these statistics, however, is that for 40 years, physicians have known about a safe medical procedure to prevent these ulcers. But the U.S. Food and Drug Administra-

tion has yet to approve the treatment.

Diabetics develop foot ulcers because of nerve damage. Injury to motor neurons deforms the feet, creating pressure points that are susceptible to harm during walking, and damage to sensory neurons prevents patients from feeling anything. “They lose the gift of pain,” explains David Armstrong, a surgeon and a podiatric medicine expert at Rosalind Franklin University in Chicago. Unaware that anything is wrong, patients continue to walk and end up wearing out

the protective fat pad between the skin and the bone in those areas. Eventually the skin erodes away, and an ulcer forms. They “wear a hole in their foot just like you or I might wear a hole in our shoe,” Armstrong says. Left untreated, an ulcer can become infected or gangrenous and can lead to foot or leg amputation—if it does not cause sepsis, a blood infection, first.

The best way to prevent ulcers is to relieve pressure on the exposed parts of the feet. Doctors have historically prescribed

special shoes or inserts, but few people remember to wear them because they are not in any pain, says Sol Balkin, a podiatrist who recently retired from the Los Angeles County + University of Southern California Medical Center. So, after seeing a hospital lecture in 1963 about the use of injectable liquid silicone to boost breast size, Balkin got an idea. What if he could inject a small amount of silicone into the ball of the foot to replace the lost fat pad and redistribute foot pressure—creating a kind of internal orthotic?

Balkin tested his idea on a few willing patients and was elated to find that it worked. “Essentially the silicone acts as a soft-tissue substitute,” he explains. He began injecting more patients, following their symptoms for years and gathering postmortem data; in the meantime, a separate clinical trial was conducted in England. All the peer-reviewed studies revealed that the injections safely and effectively prevent ulcers, although sometimes patients require boosters.

The treatment, however, has yet to make it to market, and, as Balkin contends, it’s all politics. In 1998 silicone manufacturer Dow Corning (which also sponsored

one of Balkin’s studies) settled a multibillion-dollar class-action lawsuit after allegations that silicone breast implants caused immune disorders and cancer—a suit that forced Corning out of the medical silicone implant business entirely. Silicone had become synonymous with poison, an unfortunate association that has lingered despite evidence that the material is perfectly safe, says Dick Compton, CEO of NuSil, the world’s biggest supplier of medical silicone for long-term implantation. “The safety of silicones, the information on that, is abundant,” Compton maintains.

In 1999 the Institute of Medicine, an organization designed to provide evidence-based advice on health issues, largely debunked any association between silicone, immune disorders and cancer. But the FDA has been slow to respond—it finally lifted its ban on cosmetic silicone breast implants in November 2006—and the agency admits that it still “has serious safety concerns about liquid injectable silicone,” according to FDA spokesperson Josephine Tropea. Only one product, an injectable liquid silicone treatment for retinal detachment, has been approved to date. (Balkin has used injectable liquid silicone in

an “off-label” manner to treat his patients.)

Despite the frustrations, Balkin never gave up—he continued to try to recruit companies to pursue FDA approval for his treatment. Four expressed interest, only to back out later because of fears over product liability. “They said, ‘We don’t want to go through what Dow Corning went through,’” Balkin recounts. It does not help that the product cannot be patented, he adds, because it is just liquid silicone.

But the tide may be turning. Balkin has started working with a Tennessee-based company that expects approval to market the treatment in Europe by the end of the year. Soon afterward the company plans to approach the FDA. Still, the agency may decide that additional studies are necessary, which could cost millions and take years to complete, Balkin says.

But he has a good feeling that this time, science might just prevail over politics. “To have lived through this, and hopefully live long enough to see it finally happen in my lifetime,” says Balkin, who recently turned 82, “I’d be one happy guy, to say the least.”

Melinda Wenner is based in New York City.

ENERGY

Rotor in Motor

Replacing aluminum with copper in electric motors saves energy **BY STEVEN ASHLEY**

A few percentage points of improvement in energy efficiency are rarely noteworthy, but those digits add up fast when the technology involved annually consumes several hundred billion kilowatt-hours of electricity worldwide. About two thirds of the juice used by American industry, for example, drives the countless electric motors running pumps, compressors, fans, conveyors and other devices in factories and plants nationwide, according to the U.S. Department of Energy. After a decade-long R&D effort, engineers have succeeded in wresting a bit more efficiency from these motors. And

industry has just begun to take notice.

Small versions of so-called three-phase AC induction motors, which generate from one to 20 horsepower, can convert as much as 90 percent of the power they

draw into rotary mechanical force. Today’s standard designs feature rotors—rotating electromagnetic armatures—composed of die-cast aluminum, but motor engineers have

On the Road with Copper

Several innovative vehicles incorporate large, high-efficiency electric motors with die-cast copper rotors. The Tesla Roadster (*right*), a battery-powered electric sports car from Tesla Motors that can run from zero to 60 miles an hour in 3.9 seconds, owes its 200-mile driving range to a 250-horsepower copper-rotor motor. The U.S. Department of Defense’s next-generation Heavy Expanded Mobility Tactical Truck, a multiton hybrid transport vehicle that can power field hospitals, command centers or airstrips, uses a 140-horsepower electric motor with a die-cast copper rotor to drive each wheel.



TESLA MOTORS