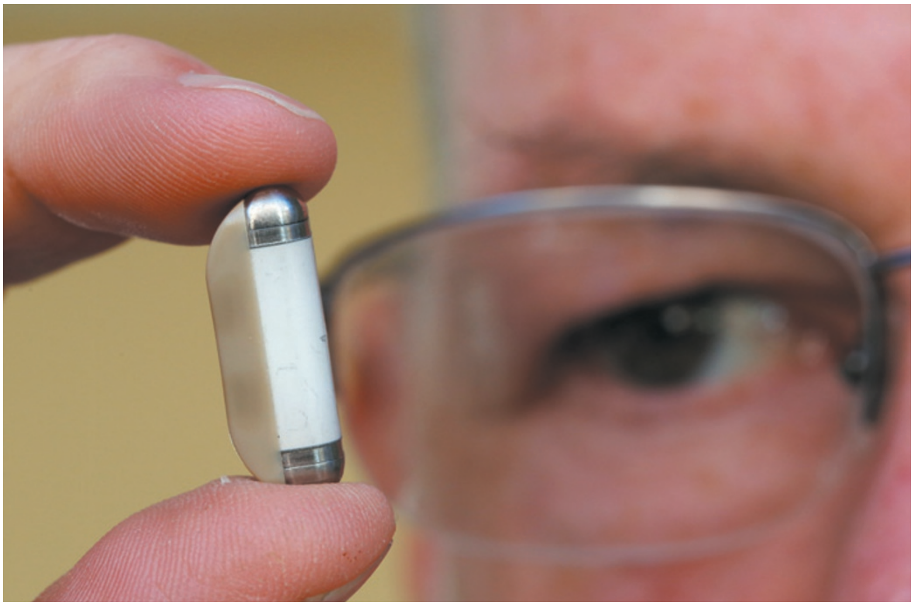

PATRICK T. FALLON

A microregulator implant made by SetPoint Medical is designed to stimulate nerves to reduce inflammation.

TECHNOLOGY

Electroceuticals spark interest

Industry and academia invest in treating diseases by delivering electrical charges to nerves.

BY SARA REARDON

When drugs can't coax cells in the pancreas to produce insulin, or loosen arteries to reduce blood pressure, a well-placed jolt of electricity might do the trick. Spurred by decades of success with pacemakers and cochlear implants, and by advances in miniaturized technology, interest is surging in 'electroceuticals' — bioelectronic implants that stimulate nerves to treat disease.

Next week, the US National Institutes of Health (NIH) will announce a US$248-million effort to map the body's electrical wiring and develop such devices. Pharmaceutical giant GlaxoSmithKline (GSK) has already set up a similar programme — and biotechnology companies are on the verge of bringing products to market.

On 1 May, the US Food and Drug Administration (FDA) approved a device by Inspire Medical Systems of Minneapolis, Minnesota, that stimulates airway muscles to treat sleep apnoea by regulating breathing while a person sleeps. And on 17 June, an FDA advisory committee recommended that the agency approve a weight-control device from EnteroMedics in St Paul, Minnesota. Implanted between the oesophagus and stomach, it stimulates the vagus nerve to make a person feel full.

Scientists predict that there are many more devices to come. "The nervous system is crisscrossing our viscera to control many aspects of our organ function," says Kristoffer Famm, head of the bioelectronics unit at GSK in London. Rather than targeting cells with a drug, he says, treatments could send an electrical pulse to a major nerve to alter the commands an organ receives, and thereby control its function.

Such treatments could be more precise than pharmaceuticals, says Brian Litt, a bioengineer at the University of Pennsylvania in Philadelphia. In autoimmune diseases, for instance, it may make sense to place an electroceutical device on a well-chosen nerve rather than to blast the whole immune system with a drug. Disorders that involve targets such as the bladder, whose function is controlled by several nerve inputs, and the vagus nerve, which has a role in numerous systems including the inflammatory response and appetite, also seem ripe for electrical interventions.

"Traditional approaches of drug discovery and swallowing a pill will not be the optimal way to treat a number of diseases," says Warren Grill, a biomedical engineer at Duke University in Durham, North Carolina, who studies electrical control of bladder function.

With that in mind, last December GSK announced a $1-million prize for the first team to develop a miniaturized, implantable device that can read specific electrical signals and stimulate an organ to perform a specific function reliably for 60 days (K. Famm *et al. Nature* **496,** 159–161; 2013). The company has spent $50 million on in-house electroceutical research, and it is also funding a consortium of scientists at 25 universities to develop devices that can be made available to the broader research community. Famm says that the researchers are working on electroceuticals for 20 different disorders that range from cardiovascular disease to rheumatoid arthritis and cancer. "It's a fascinating time, although we don't expect all those organs to be a slam dunk," he says.

Bioelectronic implants seem promising, but it is often unclear why they work. "Right now, a lot is based on phenomenology," says Kip Ludwig, director of neural-engineering programmes at the US National Institute of Neurological Disorders and Stroke in Bethesda, Maryland. "You put an electrode in the body, you stimulate, and you get an effect."

The NIH electroceuticals project, tentatively called Stimulating Peripheral Activity to Relieve Conditions (SPARC), plans to bridge the knowledge gap by taking a step backwards and focusing on the mechanisms that underlie electrical control of organ systems. Its first grants will be awarded in early 2015. Over the next six years, the agency hopes to map the nerves and electrical activity of five yet-to-be-decided organ systems and then develop electrode devices that can attach to the nerves and maintain high-resolution recording and stimulation interfaces with them for decades without causing damage.

The most challenging task will be teasing apart the hundreds of signals that run to and from each organ. The goal is to build devices that target only the signal that elicits a desired effect, and not those that could alter functions in other parts of the body, says Litt. It is a mammoth task, he adds: "It's like putting a device across a highway, and trying to figure out, by looking at the cars passing, which will get off at which exit." ■

CORRECTION

The News Feature 'Big players' (*Nature* **510,** 204–206; 2014) erred in saying that Mario Hamuy was the only university graduate in Chile in 1982 interested in pursuing graduate studies in astronomy. He was one of just a handful of such students. The article also misnamed the organization that runs the Paranal Observatory — it should have read the European Southern Observatory's Paranal Observatory.