The Making of a Nanomembrane

Greg Madejski held his breath as he looked into the microscope, trying to weld two fingernail-sized chips together: a tiny chip containing a nanofilter on top of another chip with a DNA sensor.

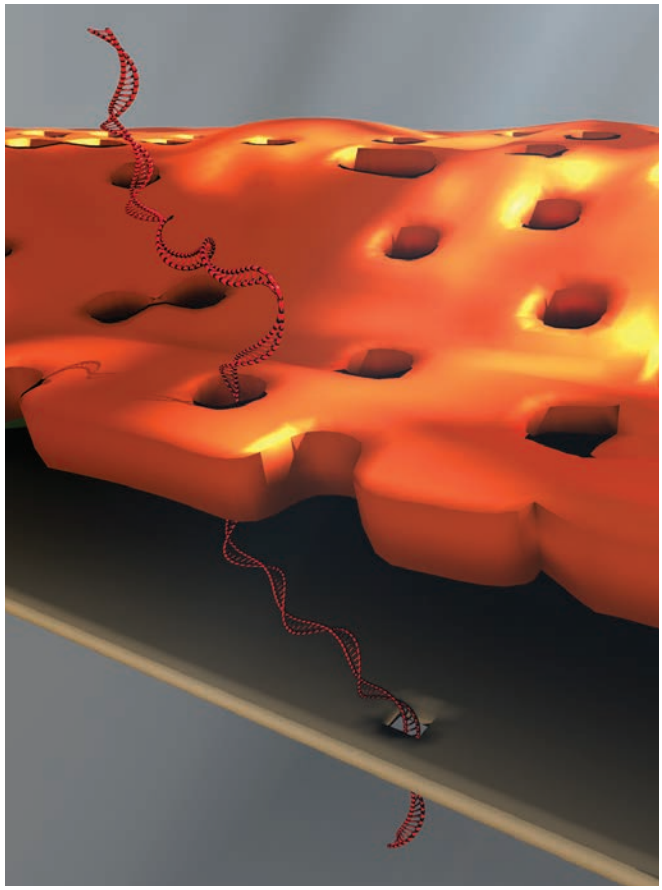
It was frustrating work. The chips weren't making good contact with each other. Madejski gently poked at the chips, then peered over the top of the microscope.

And exhaled.

The sudden waft of warm air swept over the nanofilter, transferring it ever so neatly on the target. The "accident" led Madejski—a PhD student in the lab of biomedical engineering professor James McGrath—to an important insight: that the condensed water vapor in his breath had caused the nonfilter to adhere to the sensor.

The result of Madejski's work is a novel device for detecting DNA biomarkers affiliated with disease.

Described in *Nano Letters*, it's comprised of three ultrathin layers: a nanoporous silicon nitride membrane which serves as a prefilter; a biosensor membrane with a single nanopore; and a spacer layer, filled with less than a femtoliter of fluid, that allows the two outer layers to adhere.



DISEASE DETECTIVE: A Rochester-developed nanomembrane consisting of three layers can detect DNA biomarkers affiliated with disease.

During operation, the device uses an electric field to lure a strand of DNA to enter one of the pores of the prefilter and then pass through the spacer layer to reach the pore of the underlying sensor membrane. That triggers changes in the device's electrical current that can be detected and analyzed. —Bob Marcotte

Even Adults Need 'Time Out'

In both her daily life and in her life as a scholar, Thuy-vy Nguyen has observed that solitude is often discussed as something that's either "good" or "bad." But the doctoral candidate in Rochester's Department of Clinical and Social Sciences in Psychology posed an alternative question about solitude.

"I decided to take a step back and just simply look at what solitude does, observe its effect, and let it speak for itself," she says.

The results, published in the *Personality and Social Psychology Bulletin*, suggest that as little as 15 minutes of solitude decreases a person's strong positive and negative emotions, inducing calm. That can lead to relaxation and stress reduction—as long as people actively choose to be alone, adds Nguyen.

The study defined solitude as "a psychological experience of being alone without communications, stimuli, activities, or devices that might facilitate virtual communications such as text messaging or social media."

"When people willingly spend time alone, they reap the greater benefits—something that, of course, has always been a part of ancient wisdom and practices," says Richard Ryan, a professor of psychology at Rochester and a coauthor. "Here we simply demonstrate the emotional changes that account for these benefits." —Sandra Knispel

New Directions in Neuroprosthetics?

Novel research is helping scientists figure out how to harness the brain's plasticity to rewire neural connections lost through injury or stroke.

In a study published in the journal *Neuron*, Marc Schieber, a professor of neurology at the Medical Center, and Kevin Mazurek, a postdoctoral fellow in Schieber's lab, show that very low levels of electrical stimulation—delivered directly to an area of the brain responsible for motor function—can take the place of signals that the brain typically processes in response to sounds, images, and other sensory perceptions.

"The analogy is what happens when we approach a red light," says Schieber. "The light itself does not cause us to step on the brake.

"Rather, our brain has been trained to process this visual cue and send signals to another part of the brain that controls movement. In this study, what we describe is akin to replacing the red light with an electrical stimulation which the brain has learned to associate with the need to take an action that stops the car."

The findings could have significant implications for the development of brain-computer interfaces and neuroprosthetics, allowing people to control prosthetic devices by tapping into the electrical activity of their brain.

"Most work on the development of inputs to the brain for use with brain-computer interfaces has focused primarily on the sensory areas of the brain," says Mazurek.

The study shows "you can expand the neural real estate that can be targeted for therapies" by bypassing damaged parts of the brain where connections have been lost.

—Mark Michaud

GREG MADEJSKI

In the Mystery of Positrons, Dark Matter Is Leading Suspect

'OBSERVING' DARK MATTER? Dark matter can't, in fact, be seen. But this gamma-ray observatory in central Mexico, built with the help of Rochester researchers, may have detected signs of its workings.

In 2008, satellites detected an unexpectedly large presence of high-energy positrons—antimatter particles with the same mass as an electron, but with a positive charge—in our neighborhood of the galaxy.

Researchers proposed several explanations, including that they had come from pulsars—massive stars that have collapsed and exploded, spinning and throwing off electrons, positrons, and other matter. But in a report published in *Science*, researchers at the High Altitude Water Cherenkov (HAWC) Gamma Ray Observatory in Mexico report that pulsars are unlikely to be the cause of the excess positrons.

To Segev BenZvi, an assistant professor of physics at Rochester and member of the HAWC collaboration, that's exciting news. If pulsars aren't the source, then the positrons might come from something more complex and exotic: the annihilation of particles from dark matter.

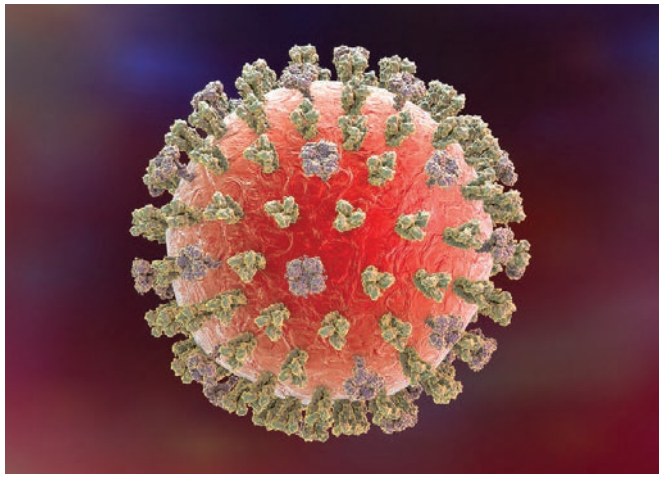
Dark matter is so named because nobody can see it, but scientists can tell it exists because of its gravitational influence. "Although this doesn't prove that dark matter is the source of the excess, we have ruled out the two most obvious source candidates," BenZvi says.

"The nature of dark matter remains one of the biggest unanswered questions in astrophysics," says Mehr Un Nisa, a PhD student of BenZvi's. "Getting closer to figuring out what dark matter is made of will help us understand how it holds galaxies together and the role it plays in large-scale structure formation in the universe."

A member of the HAWC collaboration since the observatory was constructed in 2011, BenZvi, along with PhD students Nisa and Chang Rho and postdoctoral researcher Tolga Yapici, assisted in building parts of the observatory's detector, including writing software and algorithms for measuring the gamma ray output.

—Lindsey Valich

Progress—of Sorts—in Quest for Flu Vaccine



FLOWERING FLU: The stalk-like spikes that protrude from the flu virus may be more variable, and better able to adapt to our immune systems, than researchers supposed.

Researchers around the world are pursuing a "universal" flu vaccine to protect against most or all seasonal and pandemic strains of the flu virus. Research led by David Topham, the Marie Curran Wilson and Joseph Chamberlain Wilson Professor in the Department of Microbiology and Immunology at the Medical Center, suggests that one of the most promising strategies won't be bulletproof.

That strategy has been to target the "stalk" of a protein that covers the flu virus. The hemagglutinin protein, which blankets the outside of the flu virus, looks a bit like a flower. It has a stalk and a head. Current vaccines target the head, which is the part of the virus that's always changing in an effort to evade our immune defenses.

But in the journal *Nature Scientific Reports*, Topham says that contrary to popular assumption, the stalk can also change.

Using supercomputers at the University's Health Sciences Center for Computational Innovation, Topham and colleagues analyzed the genetic sequences of human H1N1 flu viruses circulating since 1918. They found variations in both the head and the stalk, although variability was highest in the head.

In the lab, they coupled the H1N1 virus with human antibodies—immune system soldiers that fight off foreign invaders. Not surprisingly, repetitive exposure to the antibodies caused many mutations in the head, as it worked to escape the immune system's clutches.

But it also led to modifications in the stalk. The results suggest that the stalk can vary in response to pressure from the immune system.

"The good news is that it's much more difficult to drive mutations in the stalk, but it's not impossible," says Topham. "A universal flu vaccine based on the stalk would be more broadly protective than the ones we use now, but this information should be taken into account as we move forward with research and development."

—Emily Boynton

JORDAN GOODMAN/UNIVERSITY OF MARYLAND (HAWC OBSERVATORY); KATERYNA KON/SCIENCE PHOTO LIBRARY (FLU VIRUS)