

ble with normal hydrodynamic theories,” says Grimm. The damping is more compatible with theories of superfluids, evidence that the fermions are indeed forming Cooper pairs.

Now, Grimm’s group has announced another line of evidence for Cooper pairing. The researchers irradiate the condensate with radio waves and, by observing which frequencies are absorbed, determine how many atoms are bound together and how

tightly they are bound. With this technique, says Grimm, “you show how the binding energy changes with temperature.” The change matches what you’d expect with Cooper pairs, he says. As the researchers lower the temperature of the condensate, he adds, “all the completely unpaired particles disappear,” implying that the condensate should be “deeply in the superfluid regime” at cold temperatures.

Ketterle praises the work but cautions that “this experiment is not proof of superfluidity. It’s an important piece of the puzzle, but there are still other pieces missing.” He adds that researchers should have a smoking gun—such as observing quantized vortices—before declaring victory in creating Cooper pairs from fermion condensates. Only then will scientists know that each fermion has found its perfect match.

—CHARLES SEIFE

GLYCOBIOLOGY

Synthetic Vaccine Is a Sweet Victory for Cuban Science

Sin azúcar no hay país—no sugar, no country. That Cuban saying reflects the country’s historic dependence on producing sugar, an industry hit hard in recent years by falling sugar prices. But some Cuban researchers now see economic—and medical—promise in another type of sugar, the kind found on the surfaces of microbes.

On page 522, a Cuban-Canadian team reports the first large-scale production and clinical testing of a synthetic polysaccharide vaccine, one that targets the bacterium *Haemophilus influenzae* type B, or Hib, a major cause of meningitis in young children. Although commercial Hib vaccines already exist, the synthetic vaccine “has advantages for production: It’s higher quality and purer,” says study co-author Violeta Fernández-Santana, a University of Havana chemist.

Currently, companies producing carbohydrate-based vaccines resort to growing the targeted microbes and collecting their surface sugars. But manufacturing such vaccines by fermenting pathogenic bacteria in giant vats is messy, expensive, and inexact. Better, purer vaccines could be made by fashioning the sugars from scratch. But because this kind of chemistry is so dauntingly complex, nobody has developed and clinically tested a synthetic carbohydrate-based vaccine until now.

Besides leading to a cheaper, safer Hib vaccine, this work “is going to pave the way for a new generation of vaccines” against other pathogens, says immunologist John Robbins of the U.S. National Institute of Child Health and Human Development, who co-developed the first Hib vaccine. “It’s a pivotal step.”

The achievement is also a giant step for Cuba, which has built up a substantial biotechnology research program despite an economy crippled by the U.S. trade embargo and the country’s socialist system. Cuban scientists are celebrating another mile-

stone this month as well: the first U.S. license for several promising Cuban cancer drugs.

Until Hib vaccines were introduced in the 1990s, the bacterium was a leading cause of meningitis and pneumonia in children under 5. Few infections now occur in the industrialized world, but Hib still kills 600,000 children each year in developing countries. Producing the Hib vaccine by fermentation isn’t ideal—it’s hard to control the size and configuration of the sugars and costly to purify the product.

Chemists led by Vicente Vérez Bencomo at the University of Havana began working on a synthetic Hib vaccine in 1989. After meeting at a conference, Vérez Bencomo’s group teamed up with chemist René Roy of the University of Quebec in Canada and spent 2 years streamlining the synthesis of Hib sugars—for example, making an eight-unit oligomer in a single reaction rather than in 16 steps.

The chemists ultimately coupled a sugar

from Hib to a tetanus toxoid protein, which stimulates a strong and long-lasting immune response. Working with four other Cuban institutes, including the Center for Genetic Engineering and Biotechnology, they tested this compound in animals, then adults, and finally children in Cuba. The synthetic vaccine generated an antibody response comparable to that of existing vaccines. The potentially cheaper Cuban vaccine could help the World Health Organization reach its goal of vaccinating all children against Hib, notes Roy.

Cuba is working on other synthetic vaccines, including one against the *pneumococcus* bacteria that cause pneumonia, Fernández-Santana says. Indeed, the Hib example will spur “a major move in the entire area of carbohydrate-conjugate vaccines” for diseases ranging from staph infections to malaria and AIDS, predicts chemist Peter Seeberger of the Swiss Federal Institute of Technology in Zürich.

The success of the synthetic vaccine attests to the growing strength of Cuban biotechnology, an industry in which President Fidel Castro has invested more than \$1 billion since the 1980s (*Science*, 27 November 1998, p. 1626). Cuban scientists have pushed ahead despite obstacles such as U.S. Treasury rules that ban companies with U.S. branches from licensing Cuban technologies.

That makes a Treasury Department decision last week to allow a California company called CancerVax to license three Cuban cancer vaccines “a huge breakthrough,” says David Allan, CEO of YM BioSciences Inc. in Toronto, the company that initially licensed the technology from Cuba’s Center of Molecular Immunology. The United States approved a license for Cuba’s meningitis B vaccine in 1999, but this is the first license for a biological product, according to Allan.

Biotech experts say they expect much more from Cuba in the coming years. “Their pipeline is very, very deep now,” says James Larrick, a biotechnology entrepreneur in Palo Alto, California. “It’s gone into an adolescence and it’s looking pretty good.”

—JOCELYN KAISER



Sugar shot. Simpler synthesis of carbohydrates has led to a new vaccine for *Haemophilus influenzae* type B.

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