Sticky solution to bladder infections?

S. Langermann *et al.*/SCIENCE

Using a protein called adhesin, bacteria (bright spots) cling to bladder cells.

Like sailors who lash their boats to a dock with mooring lines, bacteria attach themselves to cells with threadlike extensions called pili. At the tip of each pilus is an adhesin, a protein designed to stick to a surface molecule of the bacterium's target cells.

Scientists have now identified an adhesin used by *Escherichia coli*, the bacteria that cause the great majority of bladder infections in women. Furthermore, experiments using mice and human bladder cells suggest that the newly discovered adhesin may serve as an effective vaccine against such infections, which generate an estimated $1 billion in medical costs annually in the United States alone.

The new adhesin, known as FimH, was discovered by a research group headed by Scott J. Hultgren of Washington University in St. Louis.

A single bacterial cell can make more than one type of pilus, notes Hultgren. *E. coli* can make both a version known as P pili, which allows it to colonize kidney cells, and one called type 1 pili, which helps it attach to the bladder.

Vaccines consisting of whole pili have been tested in the past, with little success. The vaccines protected against only a few *E. coli* strains, since the nonadhesin components of type 1 pili vary significantly among strains and the vaccines generate a poor antibody response to FimH. "The adhesin, in the context of the pili, does not provoke a strong immune response," says Hultgren.

His group decided to make a vaccine out of FimH alone, which varies little among *E. coli* displaying type 1 pili. With their colleagues at MedImmune, a biotech firm in Gaithersburg, Md., the Washington University scientists report in the April 25 SCIENCE that mice vaccinated with FimH resisted *E. coli* bladder infections. They also found, in test-tube studies, that antibodies from the vaccinated mice protect human bladder cells from *E. coli* attachment.

The FimH antibodies made by the vaccine seem both to identify bacteria for destruction by the immune system and to prevent the pili from latching onto cells. "It's a double whammy," says Hultgren.

One concern about a FimH vaccine is whether it might also eliminate the beneficial *E. coli* that populate the human stomach.

"It will take further investigations to address that point," acknowledges Hultgren.

Some specialists in urinary tract infections question the need for such a vaccine. "This is very nice science, but is it relevant to the clinical setting? I'm not particularly sold on these vaccines," says Calvin M. Kunin of Ohio State University School of Medicine in Columbus.

The majority of women suffer only occasional bladder infections, and those can be managed with antibiotics, notes Kunin. He adds that a FimH vaccine probably will not work against the *E. coli* that target the kidney or against the other bacteria that can cause bladder infections.

Nonetheless, MedImmune is proceeding with plans to test the FimH vaccine in monkeys. Hultgren observes that this FimH vaccine may ultimately serve as a test case for adhesin-based vaccines against bacterial illnesses such as ear infections, pneumonia, and gonorrhea.

"The other approach we're excited about is to develop therapeutic compounds that block the assembly of these adhesins," he adds. — *J. Travis*

Quantum collapse of an atomic cluster

Hulet *et al.*/Rice Univ.

An array of six magnets traps a clump of lithium atoms chilled to a temperature near absolute zero.

Though vastly different in scale, a giant star near the end of its life and a clump of lithium atoms chilled to a temperature near absolute zero may share a similar fate.

In a supernova, immense gravitational forces drive a star's collapse, which in turn triggers the explosive disintegration of the star. Recent theoretical work suggests that a sufficiently large number of lithium atoms congregated in a state of matter known as a Bose-Einstein condensate can likewise collapse into a denser state, then explode.

Randall G. Hulet and his coworkers at Rice University in Houston described indirect evidence of this atomic phenomenon this week at an American Physical Society meeting in Washington, D.C.

At room temperature, atoms of a gas move about independently, bouncing around and traveling in random directions. At extremely low temperatures, however, atoms of such elements as lithium, sodium, and rubidium collectively enter the same quantum state and act as a single, coherent unit, creating a Bose-Einstein condensate (SN: 2/8/97, p. 87).

In such a state, rubidium and sodium atoms weakly repel each other, whereas lithium atoms attract each other (SN: 9/9/95, p. 164). "Lithium atoms tend to clump together," Hulet says. "They want to collapse into a denser state."

Nonetheless, a cloud of lithium atoms confined in a magnetic trap can remain stable because of a quantum effect that generates enough internal pressure to stave off collapse. Quantum theory suggests that a trapped clump can contain a maximum of about 1,400 atoms.

Recent experiments by the Rice group demonstrate the existence of such a limit. "We never see more than about 1,000 atoms in the condensate," Hulet says.

"If you put in more atoms than that, the condensate is unstable," he notes. In this case, the extra atoms could simply leak away, leaving the clump to return to its stable state. Alternatively, the additional atoms could trigger the rapid collapse of the entire condensate.

"Here, we're talking about the possibility of observing all the atoms in this coherent entity collapsing together at once," Hulet says. "This is similar to what happens in a supernova."

Theoreticians predict that such an outcome is possible because of a process called macroscopic quantum tunneling, which makes possible a wholesale transformation of the condensate from a low-density gas to a higher-density state.

During the collapse, the atoms would collide and stick together as molecules. Molecule formation releases energy, and the collapsing condensate would quickly heat up and blow apart, shooting atoms out of the magnetic trap.

The observation that lithium condensates never contain more than about 1,000 atoms indicates that such a phenomenon may be occurring, Hulet says. The Rice team is now trying to observe directly the collapse of a lithium condensate and its aftermath. — *I. Peterson*