In the mouths of babes: No more cavities?

The next time your dentist finds a cavity in your mouth and pulls out a squealing drill, you can blame it all on your mother.

Using a sophisticated technique called DNA fingerprinting, dental researcher Page Caufield has demonstrated that mothers serve as the source of the major cavity-causing bacteria in their children. Caufield, of the University of Alabama School of Dentistry in Birmingham, also discovered that these bacteria infect children only during the 12 months following the eruption of baby teeth – a period he calls the "window of infectivity." If scientists could find a way to stave off infection during this critical time, they might prevent 95 percent of all cavities, he suggests.

The decay-causing bacteria, *Streptococcus mutans*, is spread through saliva, explains Caufield, who has submitted his research report to several scientific journals. While kissing would be the most direct means of transmission, he emphasizes that it's not the only means. "Saliva is ubiquitous," he says. "It can be spread simply by talking."

In his study, Caufield tracked 46 mother-child pairs from the infant's birth up to age 5. He deliberately selected women who harbored three times the normal level of *S. mutans*. All participants drank from the same fluoridated water supply.

Every three months, Caufield examined each child's saliva. If *S. mutans* showed up, he compared swatches of its DNA with swatches taken from the mother's *S. mutans* to find out whether she was the source of the infection. Almost all the swatches matched up, he says.

Although earlier studies suggested that mothers play a significant role in spreading *S. mutans* to their children, Caufield says his is the first to show that the mother is the principal source. He credits that discovery to the accuracy of DNA fingerprinting. "Caufield's method of identifying the strains with fingerprinting is at the forefront of the technology that's available," observes Ronald J. Gibbons of the Forsyth Dental Center in Boston.

During the five-year study period, 38 of the 46 children acquired *S. mutans* – in each case between 19 and 31 months of age, Caufield says. The eight children who remained uninfected showed no cavities at age 5, whereas cavities developed in nine (24 percent) of the infected children. Caufield speculates that this percentage would have been higher if not for the use of fluoridated water and good oral hygiene.

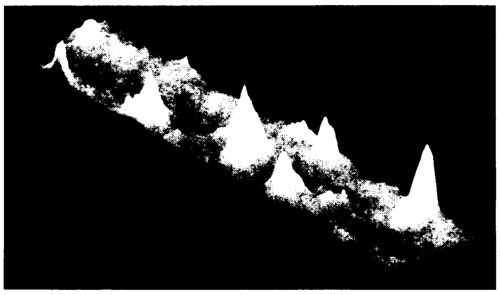
The complex ecosystem inside the human mouth – where about 200 species of bacteria establish residency – causes the window of infectivity to open and shut, he says. *S. mutans* requires a hard surface to colonize, so it cannot gain a foothold in the mouth until the teeth emerge. But if the bacterium enters the ecosystem after the teeth have already been colonized by other species of bacteria, it won't have room to settle down. The window of infectivity has closed.

Caufield says he isn't sure how eight of the toddlers managed to escape infection, but he mentions that four of them underwent extended separations from their mothers at some point during the window of infectivity, while none of the infected children experienced lengthy maternal separations at that time.

This observation provided him with a theory to explain why only a child's mother could transmit *S. mutans*: During pregnancy, every child receives antibodies programmed to behave like the mother's, so that bacteria passed from mother to child are treated as friendly, while anyone else's bacteria are recognized as alien and destroyed.

Other dental researchers express interest in Caufield's findings but remain cautious about drawing firm conclusions. "It's a study involving a couple dozen people, and it would be nice to see it involve a couple hundred people," Gibbons says. Adds Johannes Van Houte of the Forsyth Dental Center, "If it is correct, then it is a major step forward." *– M. Stroh*

Optical excitations, molecule by molecule


Basché, Moerner/IBM

Each peak on this computer image represents one impurity molecule. The placement on the long axis depends on the frequency at which the molecule resonates, while the placement on the short axis shows the molecule's location in the sample.

In a feat of spectroscopic magic, two researchers have used a finely tuned laser to transform the optical properties of individual molecules, making them "disappear" and, possibly, rendering them useful for storing information.

Last year, physicist W.E. Moerner and his colleagues at the IBM Almaden Research Center in San Jose, Calif., demonstrated that they could monitor the light given off by single molecules lodged in a crystal (SN: 1/19/91, p.37). Now, Moerner and IBM physical chemist Thomas Basché have discovered that single-molecule spectroscopy works with materials widely dispersed in amorphous solids, revealing interesting quantum-mechanical properties about embedded molecules. They describe their new findings in the Jan. 23 NATURE.

For their experiment, Moerner and Basché made a clear, 10-micron-thick, polyethylene film that contained the organic compound perylene. They cooled the film to 1.5 kelvins and trained a tunable laser on it. Perylene molecules resonate and fluoresce when excited by laser light of a particular wavelength. The pressure exerted by the surrounding polyethylene alters this property, so that different perylene molecules resonate at slightly different frequencies.

Using a very efficient detector to monitor perylene's fluorescence spectrum, the IBM team discovered that an excited perylene molecule puts pressure on adjacent polymers, thereby changing its local environment. That change, in turn, slightly shifts the perylene's energy levels so that it no longer responds to the same wavelength laser. The perylene ceases to fluoresce, and its spectral signal disappears.

Other scientists have demonstrated this disappearing act, called "hole burning," but with thousands to millions of molecules at the same time. "We're modifying the optical properties of this impurity molecule by molecule," says Moerner. "It's the first time anyone has done this on a single molecule."

The IBM researchers know they are affecting one molecule at a time because of the abrupt disappearance of the spectral signal, Moerner says. If they were exciting several molecules, the fluorescence would fade little by little and the signal would change gradually.

Sometimes, a molecule recovers its original state; other times, it does not, Moerner and Basché report. The more powerful the laser, the faster the molecule's signal disappears.

"In being able to switch and read the molecular state, [Moerner and Basché] have the makings of a molecular memory element," says Dietrich Haarer, a physicist at the University of Bayreuth in Germany.

Although this kind of data storage could pack information more densely than other optical approaches, the technology remains speculative, Haarer and Moerner agree. "You'd want a system that is reversible, and you'd want to be able to control when it comes back," notes Moerner. "It's just a glimmer of an idea."
– E. Pennisi