Identifying DNA by the speed of electrons

Ordinarily, a line represents the shortest distance between two points. Chances are, the straightest path also provides the quickest route.

Not surprisingly, this simple geometric truth holds sway in the world of biological molecules, where intricately twisted shapes sometimes obscure the shortest path between two positions.

Exploiting this principle, chemist Thomas J. Meade and molecular biologist Jon F. Kayyem, both at the California Institute of Technology in Pasadena, report that they are developing a new biosensing system for fast, precise detection of single DNA strands or their fragments.

The method rests on the simple premise that an electron careering down the center of a DNA helix needs less time for its journey than an electron spiraling along the molecule's edge. The new technique uses a single strand of known DNA. If a complementary (matching) piece of DNA binds to it, an electron's speed through the molecule increases, revealing the presence of the DNA being sought.

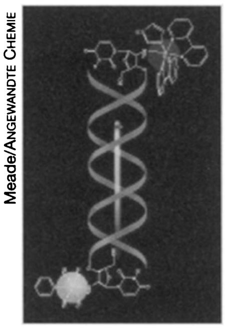
"If you know at least 20 base pairs of the DNA fragment you're looking for, you could use this method to detect it," Meade said last week in Atlanta at the annual meeting of the American Association for the Advancement of Science. "You don't even need to purify the sample. This method is selective enough that impurities can be present in the sample. All that matters is whether or not the DNA you're looking for is there."

"What we've stumbled across is a difference in two rates of electron transfer in DNA," Meade says. "One rate is for a path along the phosphate backbone of a single strand of DNA, while the other rate is for a path down the middle of the molecule. We've been able to measure that difference."

"That difference in the two rates is the key to detecting complementary strands of DNA," Meade adds.

By measuring the difference between those two electron transfer rates, the new system immediately detects whether a sample contains complementary DNA strands. A report of the electron transfer method also appears in the February issue of the German journal ANGEWANDTE CHEMIE.

Meade/ANGEWANDTE CHEMIE



An electron transverses the core of a DNA helix.

Next, the researchers want to fit their system onto disposable microchips. "We believe this technique could lead to quick, accurate, and inexpensive tests for pathogens, infectious agents, or bacteria," Meade says.

Physicians could quickly screen blood samples for genetically based illnesses or disease organisms, including HIV, the AIDS-causing virus. Meat packers could test for contamination — by toxic *Escherichia coli* bacteria, for instance — at the slaughterhouse. Agricultural researchers could monitor disease resistance in plants in the field. In environmental monitoring, this method could hasten assessments of waste sites and aid bioremediation.

"You could perform these tests on the spot without having to send samples back to a lab," Meade says. "There's a great need for fast, portable sensors like this." *— R. Lipkin*

Languishing languages: Cultures at risk

Earth's inhabitants speak some 6,000 different languages. But within the next century, 90 percent or more of that linguistic diversity — all but 250 to 600 languages — will probably disappear, says Michael E. Krauss, director of the University of Alaska's Native Language Center in Fairbanks.

This trend may facilitate communications between different peoples. However, it also threatens to erase forever aspects of the cultural identity of the tribes or ethnic groups affected, he and other linguists argued in Atlanta last week at the annual meeting of the American Association for the Advancement of Science. Indeed, Krauss likened linguistic diversity to a cultural ecosystem — a "web of life" inside which distinct social groups have evolved, each articulating its "different way of seeing the universe."

Language not only assigns names to objects and abstractions, it also reveals the importance a particular culture places on kinship and other relationships between individuals, observed Kenneth Hale of the Massachusetts Institute of Technology. Some languages he has studied also suggest subtle, but potentially important cultural distinctions, such as whether a tree is considered animate.

Hale, whose research has taken him around the globe, has the dubious distinction of having studied with speakers of eight now-extinct languages.

Leanne Hinton of the University of California, Berkeley, studies a host of dying tongues much closer to home. Of North America's roughly 250 Native American languages, perhaps 25 percent are spoken in her state — placing California behind only New Guinea and the Caucasus in linguistic richness.

However, none of California's native languages is being taught to children or used in daily conversation, she reported. Moreover, the vast majority of the state's roughly 50 extant native languages have 10 or fewer fluent speakers — all of them age 70 or older. Of these languages, 18 linger in the memory of just one to four elders. A 19th — northern Pomo — succumbed 3 weeks ago, with the death of its last speaker.

"This happens at least once a year now — that a California language goes extinct," Hinton says.

Despite this dire outlook, several promising efforts may postpone the extinction of others. Over the past 2 years, a few tribes have launched language-immersion summer camps lasting up to 2 weeks, she says. And several others, including the Yowlumni and Hupa, plan to "set up a preschool where their language will be the language of instruction."

Those most passionate about developing such programs are young adults, she notes. But "they aren't the ones who speak the language." So she's helped develop a master apprentice program that has paired 30 young language activists with 30 tribal elders. The young men and women spend at least 20 hours a week speaking the dying tongue with a relative.

The 2-year-old program, which involves 10 California tribal languages, has just obtained a federal grant to sponsor five more apprentices this spring under the newly funded 1990 Native American Languages Act. This law makes it "the policy of the United States to preserve, protect, and promote . . . Native American languages."

Hinton also described preliminary plans for a conference this summer at which members of California tribes with extinct languages might begin studying recordings, a dictionary, and documentation of their forgotten language's grammar. "Their goal," she says, "is to speak the language again."

But that's probably impossible, she concludes. Today, California's native languages hold on only as second languages. And adults who learn a second language not only tend to retain a foreign accent — in this case, English — but also to employ simplified, often faulty grammar and to import words from their first language.

"So if any of these ever became first languages again," she predicts, "they would be new, somewhat mixed languages." *— J. Raloff*