reliable. There is a potential for bias in the study. Everyone knows the hypothesis we are testing"—that meat or meat products were responsible. Nevertheless, Monk told *Science*, he has developed his own hypothesis about the source of infection in the town, which he declines to state publicly at this point to avoid bias in the study. Monk is now testing his hypothesis by asking every parent in Queniborough with children aged 19 to 35 to fill out a new questionnaire about what they fed their offspring between 1975 and 1990, the period during which most exposure to BSE is likely to have taken place. "I am confident that we will find the link between these cases," he says.

Will says that although this knowledge would come too late to help victims of vCJD, it could be important to their families, many of whom are worried that the brothers and sisters of their stricken children might have eaten the same products and thus also face a risk of dying from the disease. And this information might help Lowman comfort the distraught family members she sees each week, by convincing them that they could not possibly have known that the food they gave their offspring was infected. "The parents often feel very guilty," Lowman says. "They are terribly upset that they might have exposed their own children to something that made them ill."

–MICHAEL BALTER

TEACHER TRAINING

How to Produce Better Math and Science Teachers

In two new reports on improving science and math education in the United States, National Research Council panels call on universities and school districts to share responsibility for educating teachers and suggest that new Ph.D.s are an untapped source for high school teachers.

Schools, Universities Told to Forge Links

Universities train most of the nation's science and math teachers. But it's the job of local school districts to ensure that they keep up with their field once they enter the classroom. That bifurcated system needs to be ended, says a new report* from the National Research Council (NRC), if the country hopes to improve student performance in math and science. That message is likely to be repeated next month, sources say, when a high-profile commission issues its recommendations on how to improve the quality of the nation's math and science teachers—and puts a price tag on the reforms.

"Universities have to attract students to their education departments, but after they graduate and find jobs as teachers they are no longer a client of the university," says panel member Mark Saul, a teacher at Bronxville High School outside New York City and an adjunct professor of mathematics at City College of New York. "And school administrators have to deal with so many noneducational crises that they're happy if the kids are in their seats and there's a licensed teacher in each room. As a result, attention to the actual act of instruction gets lost."

The NRC panel says that the best way to improve teacher education is to make it a continuum, with school districts taking more responsibility for the initial preparation of new teachers and university faculty playing a bigger role in ongoing professional development. The change will require both sectors to work together more closely. It also recommends that universities improve the content of undergraduate science and math courses for prospective teachers, model appropriate practices for teaching those subjects, and do more research on the art of teaching and how students learn. In turn, school districts should make better use of teachers who have mastered these skills, giving them more opportunities to share their knowledge with their colleagues and with student teachers.

Reeducation. Teachers need a continuum of training, says a new report, to keep abreast of latest pedagogy and new knowledge.

Such a partnership already exists in Maryland, notes panelist Martin Johnson, a professor of mathematics education at the University of Maryland, College Park, in the form of four Professional Development Schools (PDSs). PDSs bring together prospective teachers and experienced staff in a formal arrangement that goes beyond both regular student teaching and standard after-school workshops. "In the past, we would send students to a school and they'd be assigned to one teacher," says Johnson. "We're asking the school to incorporate the student teacher into a broader range of experiences, with input from other faculty members as well as other teachers."

Jim Lewis, head of the math department at the University of Nebraska, Lincoln, and co-chair of the NRC committee, compares this approach to training doctors. "Medical students take courses from both research and clinical faculty," he explains, "and their residencies are overseen by practicing physicians. Likewise, an experienced classroom teacher may be a better mentor [to a prospective teacher] than an education professor who focuses on research." That shift, says Lewis, will allow research faculty to devote more attention to helping experienced teachers stay on top of their field through advanced courses, summer research projects, and other professional activities.

The National Science Foundation, which paid $425,000 for the report and two related activities, has already begun to support the types of partnerships the NRC panel calls for. It has asked for $20 million next year to expand a program on university-based Centers for Learning and Teaching with teacher training as one of three primary foci.

The NRC report also dovetails with the pending recommendations of a blue-ribbon federal commission headed by former U.S. senator and astronaut John Glenn. "I was struck by the amount of overlap," says Linda Rosen, executive secretary to the commission, whose report is due out on 3 October (www.ed.gov/americacounts/glenn/toc.html). "There's a growing sense that we have to break down the barriers between elementary

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* Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium, 2000 (national-academies.org).

and secondary schools and higher education and bring all the available talent to bear on the problem of math and science teacher education." Rosen says the commission will flesh out the NRC's findings "by laying out a set of strategies and price tags that makes clear who needs to do what."

Although Lewis welcomes the heightened attention on teacher education, he says that reports won't help unless they are backed up by a national consensus that teachers count. "The schools [in Lincoln, Nebraska] start this week, but they'll close early if it gets too hot because they lack air conditioning," he says. "I'll bet that you work in an air-conditioned building. So why can't teachers? Because we aren't willing to pay what it would cost."

Can New Ph.D.s Be Persuaded to Teach?

U.S. schools will need to hire 20,000 math and science teachers a year for the next decade to handle a growing student population and high rates of retirement, according to government estimates. Where they will come from is anyone's guess, as schools are already having trouble finding qualified people. To help fill the gap, a National Research Council (NRC) committee suggests tapping a talent pool that is relatively underrepresented among teachers: newly minted Ph.D.s.

In a report* issued last week, the committee says many more recent science Ph.D.s would be willing to teach high school science and math if the government helped with the transition, if the certification process were compressed, and if they could retain ties to research. The committee recommends that the NRC help states with pilot projects that, if successful, could be expanded nationwide. But some educators are skeptical, noting that Ph.D.s may not be properly trained and that the research and teaching cultures are very different.

"If public schools could place an ad that read: 'Good salaries, good working conditions, summers off, and tenure after 3 years,' I think they'd get a good response from graduate students," says Ronald Morris, a professor of pharmacology at the University of Medicine and Dentistry of New Jersey in Piscataway and chair of the NRC panel, which last summer surveyed 2000 graduate students and postdocs as well as interviewing professional educators. "But most Ph.D.s don't know about the opportunities, because they are generally far removed from the world of K-12 education."

The report notes that while 36% of respondents say they had considered a K-12 teaching job at some point in their training, only 0.8% of the scientific Ph.D. workforce is actually working in the schools. "That's a significant pool of talent that we're ignoring," says Morris, who acknowledges that none of his 40 postdocs over the years has chosen to go into high school teaching.

Professional educators, however, warn that several issues must be resolved, including the teaching skills of recent Ph.D.s and how well they would fit into a high school environment. "I think it's a great idea," says Mike Lach, a high school physics teacher in Chicago who just completed a sabbatical year in Washington, D.C., working on federal legislation to improve math and science teaching (*Science*, 4 August, p. 713). "But teaching is hard, and those in higher education traditionally don't have much respect for classroom teachers." Mark Saul, a Ph.D. math teacher in Bronxville, New York, as well as an adjunct professor at City College of New York, puts it this way: "Ph.D.s are a peg with a different shape than the current hole for schoolteachers."

Morris agrees that high school teaching isn't appropriate for all Ph.D.s. But he believes that an array of incentives, including federally funded fellowships for retraining and summer research projects, might be just the ticket for those looking for a way out of a tight academic job market.

–JEFFREY MERVIS

* "Attracting Science and Mathematics Ph.D.s to Secondary School Education," National Academy Press.

GENETICS

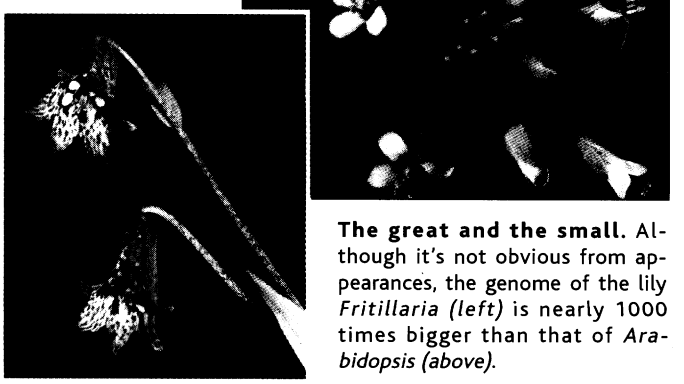
Transposons Help Sculpt a Dynamic Genome

These mobile elements cause considerable reshaping of the genome, which may contribute to evolutionary adaptability

More than 50 years ago, geneticist Barbara McClintock rocked the scientific community with her discovery that maize contains mobile genetic elements, bits of DNA that move about the genome, often causing mutations if they happen to land in functioning genes. Her findings were considered so outlandish that they were at first dismissed as anomalies unique to corn. But over the years, transposons, as the mobile elements are called, have proved to be nearly universal. They've turned up in species ranging from bacteria to mammals, where their movements have been linked to a variety of mutations, including some that cause diseases and others that add desirable diversity to genomes (*Science*, 18 August, p. 1152). Only in the past few years, however, have researchers been able to measure the rate at which transposons alter the composition of genomes, and they are finding that the restructuring they cause is more extensive than previously thought.

Researchers have known for about 20 years that transposons can expand the genome, resulting in the repetitive DNA sequences sometimes called "junk," but the new work indicates that transposons can also contribute to substantial DNA losses. What's more, these changes can be rapid—at least on an evolutionary scale. "The level of genomic dynamism is way beyond what was thought," says geneticist Susan Wessler of the University of Georgia, Athens.

The rate of transposon-mediated genomic change can vary, however, even among closely related organisms. The findings may thus help explain the so-called "C-value paradox," the fact that the size of an organism's genome is not correlated with its obvious complexity. Plants, for example, are notorious for having a 1000-fold variation in their genome sizes, ranging from the lean 125-million-base genome of *Arabidopsis* to the extravagant genome of the ornamental lily *Fritillaria*, which at 120 billion bases is about 40 times the size of the human genome. There are also hints that the environment can influence transposon activity,



The great and the small. Although it's not obvious from appearances, the genome of the lily *Fritillaria (left)* is nearly 1000 times bigger than that of *Arabidopsis (above).*

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