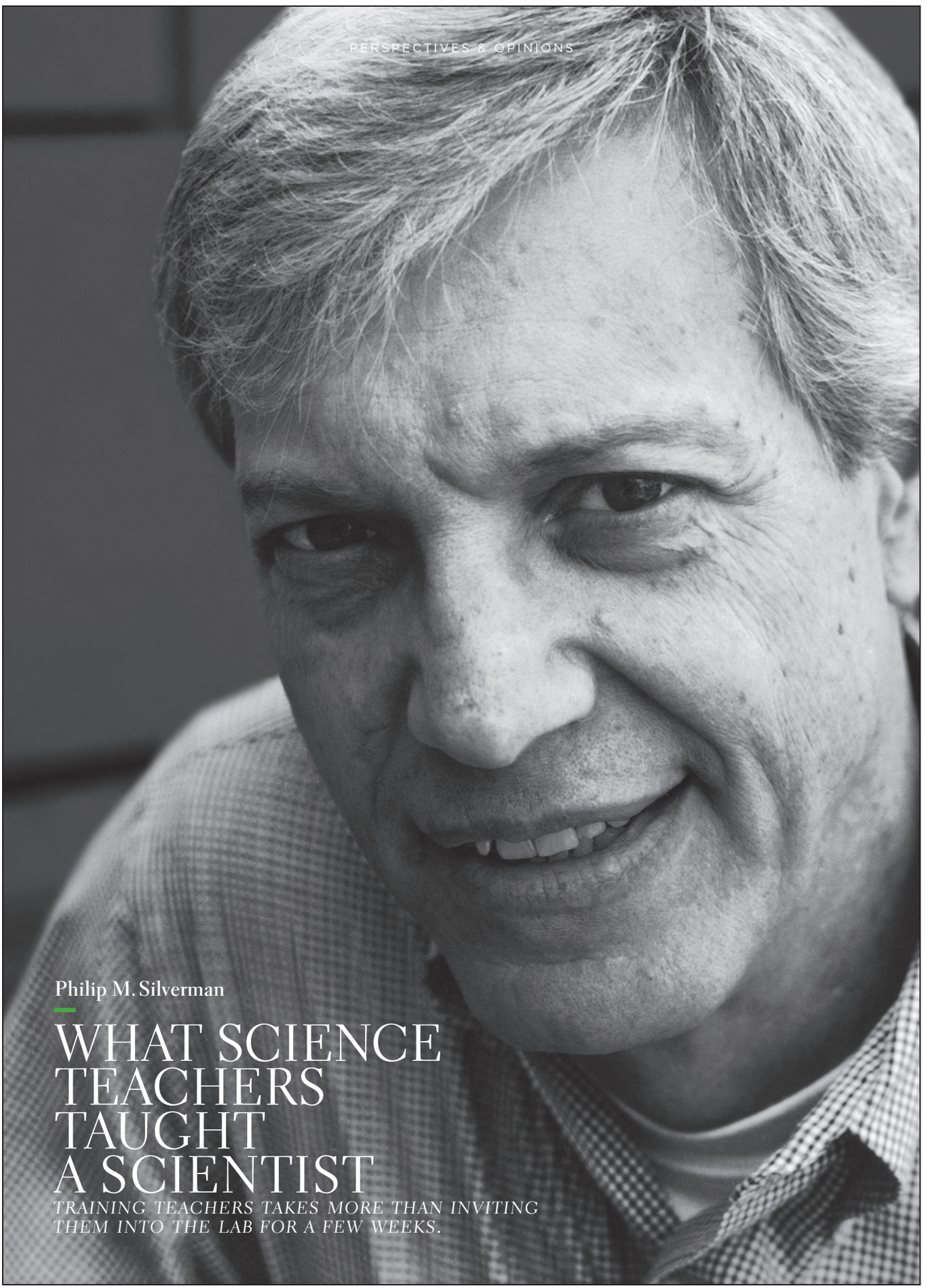

Philip M. Silverman

WHAT SCIENCE TEACHERS TAUGHT A SCIENTIST

TRAINING TEACHERS TAKES MORE THAN INVITING THEM INTO THE LAB FOR A FEW WEEKS.

Misty Keasler

After 11 years as director of the Oklahoma Science Project, molecular biologist Philip M. Silverman has learned some lessons worth passing on. The Oklahoma Medical Research Foundation (OMRF) launched a program in 1988 to provide an 8-week summer research experience for Oklahoma public high school teachers. Some teachers were inspired by their experience but were left with nothing to take back to their students except enthusiasm, which quickly faded. Today, the program looks very different but is having its intended impact.

What were the obvious things that needed to change when you began observing the program?

The original program, called the Foundation Scholar Program, was based on the expectation that working on a cutting-edge project under the tutelage of a professional research scientist would somehow make the participants more effective science teachers. But science education and scientific research are separate activities. Teachers need research training they can take back and use in their classrooms, which can be hard to find in a high-tech research lab. How many high school laboratories have a DNA sequencer? How many even have gas for Bunsen burners? Additionally, the teachers worked in separate labs on different techniques and topics. They needed an environment that encouraged ongoing interactions—with their mentor and each other—to develop experimental skills and confidence, to model a research dynamic, and to work out ways to bring back what they were learning at OMRF to their students. They needed to be together in the same lab.

How did you decide on the right experiments to use?

It hit me when I was reading the second edition of *Phage and the Origins of Molecular Biology*, edited by John Cairns, Gunther Stent, and Jim Watson (expanded edition, Cold Spring Harbor Laboratory Press, N.Y., 1992). In the preface, Cairns wrote that all of the scientists who had done these fantastic phage experiments were dying off. He said, "The era of phage is over." When I read that, I thought, "Wait a minute. It's not over at all. The teachers would love these experiments." The science is fundamental and significant and the technology is cheap and simple. That's when I asked to try out my ideas with some teachers. I crowded a group of teachers into my laboratory, taught them the classic plaque assay for bacterial viruses, gave them some muddy lake water, and started them virus hunting.

Did it make a difference?

The teachers loved it. I grew up scientifically in the era of phage; I knew it intimately. I could convey the experiments themselves, but also the context and flavor of the times. The teachers loved that too. With passing summers we added new research topics (antibiotic resistance and regulated gene expression, for example). All of the experiments are derived from materials that the teachers (and later, their students) isolate themselves (livestock manure became the most popular and reliable source of bacteria and bacterial viruses), and from questions that the isolation generates in their own minds. Still, it wasn't translating to the classroom. I would get e-mails from the teachers when they went back to their schools about science fair projects but not about using the experiments in the classroom. By the second and third year, the teachers faded away. I stopped hearing from them.

What was missing?

Eight weeks wasn't enough. We give a grad student 5 years to do independent research and get a Ph.D., but we expect teachers to go through a transformation in 8 weeks? I began allowing teachers to return to the summer course for 4-week intervals as often as they wanted. This "Return to Science," as I called it, increased teachers' confidence and was certainly popular. It was kind of a circus, with new and returning teachers sharing lab space, but it was fantastic. Nevertheless, it didn't entirely solve the problem of classroom use.

Did you ever think, "This just isn't going to work"?

The idea entered my mind, but I immediately rejected it because I had 8 weeks with these teachers. I knew their abilities in the lab and how excited they were when they did these experiments. I just had to ask why this enthusiasm wasn't spilling over into the classroom, what other possibilities constituted barriers to classroom use. *(continued on page 56)*

INTERVIEW BY CORI VANCHIERI *Philip Silverman wants to help high schoolers pose questions and find answers through experiment.*

CONTINUED FROM PAGE 27
(DATA GO AWOL)

"If publishers go out of business their online resources can vanish," says Michael Seadle, assistant director for information technology at Michigan State University and a LOCKSS user. "We want to make sure that scholars, 10 or 100 years from now, will still have access to these data. LOCKSS is a way to make sure that published information doesn't disappear, while respecting the publishers' copyright. It's a security policy for everyone."

CONTINUED FROM PAGE 41
(PHILIP SILVERMAN)

The answer?
They needed classroom support. It was naïve to expect the teachers to find time to pour 400 petri plates. It's so obvious when I say it, but it's amazing how long it took for this to sink in. So we asked the teachers to send us a shopping list. You need 400 petri plates? We'll pour them for you. You need filters to isolate your own phage? We'll send them. We send these kits overnight so they have them when they need them, and they are the key. Now we're getting repeats. Teachers are asking for this stuff year after year.

You plan to train other scientists to do what you do. What will you tell them?
I'll tell them you're not trying to turn these teachers into scientists but into better science teachers. Don't try to dazzle them with your intellect or with the cost of your toys.

Effective scientist-mentors will understand this perspective. I will also tell them that to fully engage teachers it really helps to be a bit of a ham—mentoring is part performance art. Finally, I will tell them that teachers are great about telling you what they think. Listen to them. They might even make you a better teacher. ■

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