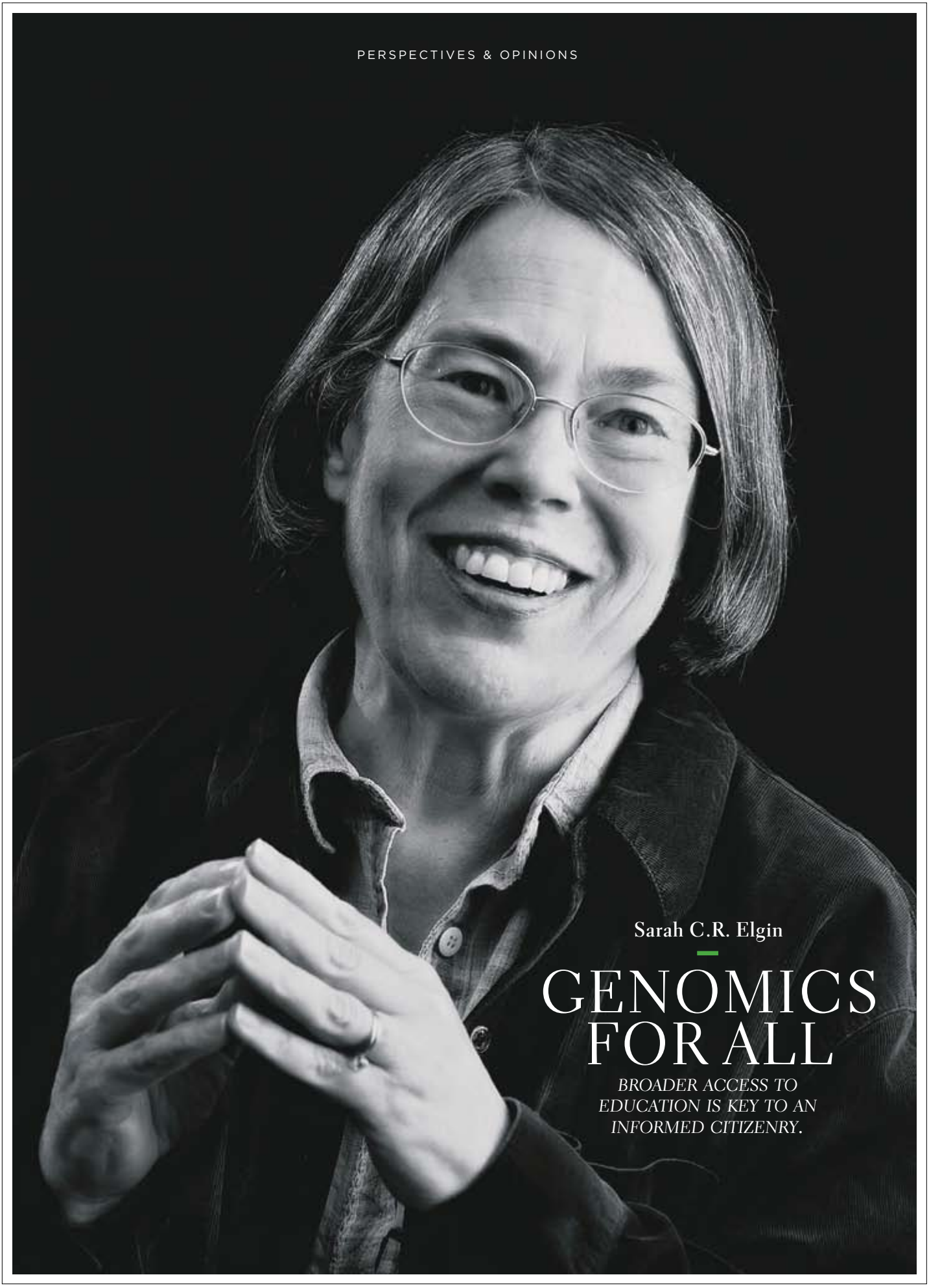

Sarah C.R. Elgin

GENOMICS FOR ALL

BROADER ACCESS TO EDUCATION IS KEY TO AN INFORMED CITIZENRY.

Scott Ferguson

Sarah C.R. Elgin likens modern gene sequencing to Henry Ford's revolutionary mass production of the automobile. Just as Ford made cars affordable, automation and high-throughput technologies have rapidly lowered the cost of gene sequencing. Now comes a new and critical responsibility, says Elgin, an HHMI professor: to train a generation of informed genomics consumers.

The next generation of consumers will be the true beneficiaries of the promise of genomics. But how will they make informed choices in a world resplendent with genomics products, including tools to predict disease and the engineered drugs to treat those diseases?

The answer is more genetics and genomics at every level of American education. When I first approached HHMI with this idea in 2002, I knew we needed to focus on the full educational continuum. Over the last five years, I and other HHMI professors have created prototypes and pilot programs for middle school, high school, and undergraduate students.

I am most excited, however, about a program we're developing at Washington University in St. Louis for undergraduates across the country, using the Internet. The Genomics Education Partnership (GEP) was born from the need to bring genomics into the curriculum, and from the realization that genomics provides a terrific vehicle for engaging undergraduates in research. Traditional research experiences for undergrads, typically offered in the summer, do not work for every student. Nor do we have the national resources to uniformly offer summer programs. Genomics provides a cost-effective way to reach out further.

GEP is a partnership between Wash U. and 17 primarily undergraduate institutions scattered across the United States. Wash U. and partner students participate in collaborative research using Web-based resources, and they ultimately go on to publish. Like their on-campus peers, GEP partner students analyze complex genomics problems while interacting with the Wash U. Biology Department and Genome Sequencing Center.

We piloted the concept with a dozen adventurous juniors and seniors at Wash U., comparing gene sequence organization on a single chromosome among various fruit fly species and drawing conclusions about the evolutionary implications. The students worked as a team, each taking on one piece of the task. Sequencing work was done with the Genome Sequencing Center, and gene annotation and analysis was completed with coaching from computer science faculty.

The course was a major success, capped by a peer-reviewed publication with 13 Wash U. undergraduate authors published in *Genome Biology* last year. Student surveys confirmed learning gains rooted in collaboration, analysis, interpretation, and pooled results. I am now convinced that collaborative research courses work and can be offered on a widespread basis, not simply at the nation's largest or wealthiest universities.

GEP is actively looking for partner institutions; we have 17 and would like 100. We are looking for faculty members who want to bring genomics into their teaching of genetics, and for faculty members who have good DNA sequence annotation projects for the students to carry out.

In my opinion, and recent experience, students everywhere want to participate in the process of science. Research is how new knowledge is generated in our field, and where students can become engaged with science in the making. As research-based learning enters the curricula, we see a critical benefit: students understand how scientists work on real problems. Those who go on to non-science careers will be more discerning consumers of technology. Plus, we'll be inspiring more students to enter science and technology careers, and giving them the foundation to do so.

Of course, I'm not the only one who has noticed the educational opportunities created by online access to databases and genomics tools. Graham Hatfull, an HHMI professor at the University of Pittsburgh, has developed a program that enables students to isolate and sequence unique phages, and he and I are working with HHMI to develop a "national experiment," called the Science Education Alliance, to engage students in this sort of research (see Chronicle, page 46).

If we're to create a genomics-knowledgeable next generation, such innovations in education are vital. Our children need the tools to make informed choices about their world, and to help them do so we have to bring genomics into schools and colleges. Elementary students can gain a basic understanding of life cycles, and by the time kids reach middle school, they're ready to start talking about DNA as an information molecule.

In another decade, genomics will be so accessible and affordable that middle school and high school students everywhere will be plucking organisms from their back yards and sequencing them—provided they have the education and tools to do so. It was, after all, Henry Ford who said, "Before all else, preparation is the secret of success."

INTERVIEW BY RICHARD CURREY. *Sarah Elgin is a biologist at Washington University in St. Louis. Information on the GEP is available at http://gep.wustl.edu.*