The 2012 Genetics Society of America Elizabeth W. Jones Award for Excellence in Education David A. Micklos

EACH year, the Genetics Society of America honors an individual who has made significant and sustained contributions in the field of genetics education. In recognition of his extensive contributions to genetics education, and for bringing a genomics curriculum to a broad audience that includes K–12 to community colleges, large state institutions, small liberal arts colleges, and the lay public, David Micklos is this year's recipient of the Elizabeth W. Jones Award for Excellence in Education.

Through his work as founder and executive director of the DNA Learning Center (DNALC) at Cold Spring Harbor Laboratory (CSHL), Dave has ushered DNA science into the educational curriculum for thousands of students, high school teachers, and undergraduate faculty. The DNALC's website alone hosts more than 7 million visitors each year (<http://www.dnalc.org>).

Sally C. R. Elgin, Viktor Hamburger Professor of Biology, Genetics, and Education at Washington University in St. Louis, Howard Hughes Medical Institute professor, and recipient of the 2009 Genetics Society of America Elizabeth W. Jones Award for Excellent in Education, describes Micklos's achievements in this way:

Dave's impact is based on three factors: the high quality of the genetics materials he has generated and supervised, judged both by scientific accuracy and clarity of communication; his ability to take the newest research tools and adapt them for student-centered investigations; and his ability to garner the funds to take his programs to large number of students, in New York, across the United States, and indeed worldwide.

Dave brings to the field a combination of education, experience, and talent, all wrapped in vision and pragmatism. His early career roles have ranged from biology teacher for the Baltimore City Public Schools to science teacher at Moeng College in Botswana while serving in the Peace Corps to Seasonal Park Ranger and Naturalist in the Maryland and the

National Park Service. He has written numerous articles and several scientific textbooks, including "Making the American Public DNA Literate" and "Genetic Testing: An Educational Imperative to Our Schools," and his most recent textbook co-authored with Bruce Nash and Uwe Hilgert, *Genome Science: A Theoretical and Practical Introduction to Gene Analysis in Eukaryotes*.

Dave has served as executive director of the DNALC since 1988, having arrived at CSHL in 1982 to start the laboratory's public affairs and development efforts.

"I do not know anyone who has made more significant contributions in bringing the excitement of genetics and genomics to a wide audience that includes both high school and undergraduate students and teachers," says Sue Wessler, distinguished Professor of Genetics at the University of California, Riverside, and HHMI Professor, who has collaborated with Micklos as part of the National Science Foundation-funded iPlant Collaborative (<http://www.iplantcollaborative.org/>). "Dave has a genius for deconstructing experimental concepts in genetics and genomics and for building tools and classroom experiences that both enrich and motivate students."

Of Cold Springs and Chances

When asked at what age he became interested in science, Dave displays characteristic, self-effacing candor. "I was not," he says, with emphasis, "interested in science in high school. In fact, in junior high, I remember sitting in the back row of the lab, playing cards or fooling around with the alcohol burner." "I slept through a lot of my chemistry course," he adds. "I liked to watch the late show and was tired by that period."

An advanced biology course in college taught by an interesting, charismatic professor sparked a long-running love of science for Dave, then an elementary education major. With a graduate degree in journalism in 1982, and working at a top New York City firm conducting sociological research, Dave was an unlikely candidate for the position as head of public affairs and development for the Cold Spring Harbor Laboratory. He had wanted to be a science journalist, but an economic recession made such jobs in short supply.

Dave was contacted by W. Howard Chase, founder of the public relations field of “issues management,” who had been charged with finding someone to lead CSHL’s public relations and development efforts. Chase had taken note of Dave’s award from the Public Relations Society of America for his master’s thesis “Constraints of Social Responsibility of Public Relations Science Writers.” Both of them had doubts about Dave’s competitiveness for the job because the nearly dozen other top candidates were mid- or late-career professionals.

But Dave landed an interview, which found him walking the banks of Cold Spring Harbor with Jim Watson, who, as he is known for, interviewed all candidates for critical roles at CSHL. As to how a recent graduate with a journalism degree won the position,” Dave quips, “I think it was the birds.” It turns out that both Dave and Watson are avid birders, and fall migration was in full swing the day of Dave’s interview. Dave recalled that, among other topics, his avian observations resonated with Jim, and he was hired.

It turned out to be a wise decision. Dave soon conceptualized and launched a 5-year, \$44 million development effort to commemorate the CSHL’s centennial year in 1990. He went on to impact science education in ways that neither Watson nor Dave himself imagined on that fall afternoon.

Reaching Out with DNA Science

A 2011 report to the Cold Spring Harbor Laboratory Board of Trustees details how the book *DNA Science* evolved:

The DNALC’s effort to develop lab experiments for high school and colleges dates to 1985, when Dave teamed with Greg Freyer to develop a sequence of experiments to make and analyze a recombinant DNA molecule. The initial testing was done in Rich Roberts’ lab, well before he had won the Nobel Prize, and incorporated key insights on inserting DNA into bacteria from Doug Hanahan. The lab sequence was initially a slim lab manual, “Recombinant DNA for Beginners,” whose title was derived from the Graham Nash record album “Songs for Beginners.”

“It [the song] expressed perfectly our ideal of making complicated gene technology accessible to novices,” says Dave.

Within a year, Dave and colleagues were training teachers across the country on summer tours of first one (and then two) customized silver Vector vans that packed enough equipment, reagents, and supplies to convert any general science lab into a molecular genetics lab. Over those miles, they developed a mini-text that presented the concepts behind the labs, plus extensions of recombinant-DNA technology in basic and applied research. In 1991, this (greatly expanded) work was published as *DNA Science*. [REF]

DNA Science, now in its second edition, has sold 90,000 copies. It is credited with catalyzing the movement to bring hands-on experiments with DNA into high school and beginning college classrooms. Experiments have found their way into the advanced placement biology curriculum and a nationwide audience, and a stand-alone kit developed

with the Carolina Biological Supply Company has sold thousands of units and reached more than 200,000 students each year.

DNALC

In addition to his work as Director of CSHL’s Public Affairs and Development, Dave was spending more time on genetics education. By fall of 1986 Dave and four staff members were running a frenetic fusion of public affairs, development, and educational outreach out of their crammed offices. “Jim supported my moonlighting because he knew it was time for the Laboratory to take the lead in fostering ‘DNA literacy’ among the general public—just as it had led the way with professional scientists,” Dave wrote in retrospective on the DNALC’s 20th anniversary. “This was a bold move at a time when high-level scientists, here and elsewhere, were expected to concentrate solely on their research.”

“Our modicum of success was not lost on Jim,” wrote Dave, “who concluded that the time had quickly come for the education program to conform to his dictum of organizational evolution: ‘You get bigger, or you get smaller.’ [Watson] determined that we should take over an excessed elementary school—a neo-Georgian building constructed in 1925 on Main Street—and convert it into a DNA museum. When the proposal was brought to the Board of Trustees. . . . Dave Botstein, then-chairman of biochemistry at Stanford University, rose to champion the proposal—and the scientific trustees fell in strongly behind him. The notion of a stodgy museum was roundly disdained, and all felt much better with the friendlier concept of a learning center.”

During the earliest lab field trips, students cut and separated viral DNA or inserted an antibiotic resistance gene into bacteria, exemplifying hands-on science. Soon, Dave began driving a 24-ft truck back and forth between CSHL and Washington, D.C., loading and unloading pieces of a 10,000-sq-ft exhibit, “The Search for Life,” borrowed from the Smithsonian Institution’s National Museum of American History. The exhibit’s unwieldy system of aluminum trusses and theatrical lights occupied the entire front hall, gym/auditorium, and two of four original classrooms of the old school. It also had artifacts like Audrey, the man-eating plant from *Little Shop of Horrors*, and a re-creation of the lab bench at which Stanley Cohen constructed the first recombinant-DNA molecule.

On September 18, 1988, the DNALC opened as the nation’s first science center devoted entirely to public genetics education. Since that time, the DNALC has conducted experiments with more than 400,000 students, safely and without incident. Its DNA Science curriculum and kits provided by the Carolina Biological Supply Company brought modern DNA manipulation to millions more high school and college students. The DNALC’s model for hands-on learning, Vector Vans, and local equipment sharing has been adopted by numerous science centers, mobile vans, and “footlocker” programs in the United States and elsewhere.

The best science museums enhance formal science education by providing insight into the process of science, which may be missed in fact-driven classrooms. The DNALC, in its role as science museum and education portal, conceived in 1995 the first major website of archival information on the American eugenics movement (<http://www.eugenicsarchive.org>). Dave describes the significant effort involved in “bringing this skeleton out of the genetics closet” and educating students, teachers, and the lay public to a period in genetics history. After substantial discussion, even at the level of the National Institutes of Health Council, the DNALC was awarded a 2-year grant from the Ethical, Legal, and Social Issues (ELSI) program of the National Human Genome Research Institute in early 1998 to create the online archive, which also received a continuation grant.

The searchable archive contains 2500 images of photographs, lantern slides, correspondence, journals, and other types of data, including Francis Galton’s work on fingerprint analysis and composite portraiture and Charles Davenport’s *Eugenics: The Science of Human Improvement by Better Breeding*. As Dave comments,

Forget about the evil applications of eugenics; any right-minded country or person should avoid them. Concentrate instead on the kinds of personal reproductive choices that become possible with genetic technology. For example, pre-implantation DNA diagnosis allows parents to pick and choose among embryos at risk for serious genetic diseases. But why not screen for genes involved in nervous development and might predict higher IQ? When it can be done, it will be done—because every parent will do what is best for his or her child. What will it be like when only the rich can afford to select intelligent children, and what will it be like when everyone is expected to?

In his recent *Science* article “Essays on science and society. Lessons from a science education portal” (Micklos *et al.* 2011), Dave wrote that “Science takes place on the continuum between research and education. . . . For the first time in the history of science, students and teachers can work with the same data, at the same time, and with the same tools as elite-level researchers.”

Dave stresses that bioinformatics has a place in discovery science and that advances in technology have made molecular genetic research egalitarian with easy-to-use online tools and readily available data. Like most science educators, Dave believes that the best science teachers enable students to actually conduct research. In undergraduate biology education, more projects are being conducted in the context of the classroom. Schools are experimenting with course-based research, where each school can do less on a project and a much larger number of students can take part. The vast amounts of accessible data and free tools allow this, Dave says, because any one school does not have the resources to generate the data.

This egalitarian model has the potential to revolutionize the way science is done. “For all of the history of biology,

hypotheses were underdetermined by data,” Dave says. “So, how many observations of a rare plant could you make in a lifetime? Not many.” Scientists generate an hypothesis and spend their entire careers trying to find some limited data to support it. “Now,” Dave points out, “we have nearly unlimited data that are undetermined by hypotheses—exactly the opposite!”

Dave says that we can “crowdsource” a specific scientific problem using “lots of kids and lots of data”—and then find out which pieces of the problem are uncovered by various individuals or groups working on it. He compares this movement to citizen science projects like eBird (<http://ebird.org>), an online database launched in 2002 by the National Audubon Society and the Cornell Lab of Ornithology into which recreational and professional birdwatchers enter their observations (3.1 million in March 2012 alone), helping scientists to take a new view (literally) of how birds migrate and creating one of the largest biodiversity data resources in the world.

Dave’s version of this egalitarian science is exemplified in DNA Subway, a powerful suite of bioinformatics tools and databases for educational purposes, developed as an outreach component to iPlant. DNA Subway’s interface enables students to annotate a plant genome, prospect for transposable elements, and analyze next-generation sequence data. Dave’s involvement extends beyond creating and disseminating DNA Subway. He and colleagues have conducted workshops for introducing the technology to high school and undergraduate students, with a special focus on minority institutions such as Spellman College in Atlanta.

Dave’s commitment to education is further demonstrated by his service as a Peer Reviewer for the National Institutes of Health’s Ethical, Legal, and Social Issues (ELSI) of Genome Research and Science Education Partnership Award programs, as well as National Science Foundation programs in Advanced Technological Education; Course, Curriculum, and Laboratory Improvement; and Research Coordination Networks.

Dave’s efforts—just a few of which have been mentioned here—have been widely acknowledged: He received the 1990 Charles A. Dana Award for Pioneering Achievement in Education and is a Fellow of the American Association for the Advancement of Science. Dave is the only CSHL employee to have received an honorary degree from its Watson School of Biological Sciences.

The Genetics Society of America is proud to add the Elizabeth W. Jones Award for Education to the list of Dave’s well-deserved accolades.

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