

DNA LEARNING CENTER

2011

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DNA LEARNING CENTER EXECUTIVE DIRECTOR'S REPORT

Preparing students and families to thrive in the gene age

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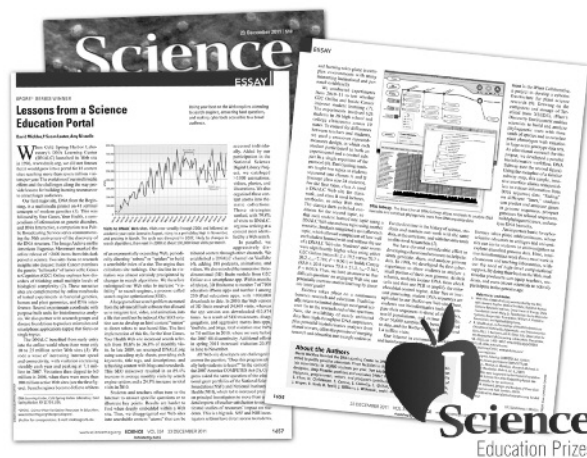
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On December 23rd, our effort in computer *BioMedia* was recognized with the *Science Magazine* Prize for Online Resources in Education. The prize essay, “Lessons from a Science Education Portal,” gave us an opportunity to look back on our success in the world of online publishing. When we launched the DNA Learning Center (DNALC) website (www.dnalc.org) in 1996, we could not foresee that it would become an Internet portal with 21 websites, a *YouTube* channel, and smartphone/tablet apps that reached 7.45 million visitors in 2011. The evolution of our online efforts and the challenges we faced along the way provide four lessons for science organizations that want to build modern learning resources.



Lesson 1: Make Content More Visible to Search Engines. After a decade of continuous growth, visitation to our websites mysteriously declined in 2007. During that period, the number of active websites had increased tenfold, to more than 100 million. In an exponentially crowded web, Google and other search engines had become the de facto arbiters of web visitation. Search engines create an index of the information at a site to scan for search term matches. A “robot” or “spider” visits a website periodically to rebuild its index. Our downturn came as Google changed its search algorithms and we lost “attention” of its robots.

We therefore embarked on an ambitious program to redesign our websites to increase “visibility” to search engines, a process called search engine optimization (SEO). This included directing robots to rich keywords and detailed descriptions of all content, especially animations and videos that cannot be indexed themselves. We also “freshened” content with blogs and newsfeeds. The SEO makeover of DNALC.org nearly doubled average monthly visits from search engine robots, resulting in a 25% increase in visitation in 2010. Continued attention to SEO is keeping us on an upward trajectory.

Lesson 2: Disaggregate and Flow Content through Multiple Channels. Everyone likes a good story,

but students and teachers most often turn to the Internet for answers to specific questions or to illustrate key points. These are much harder to find when deeply embedded within a website. Thus, we disaggregated our websites into searchable content “atoms” that can be accessed individually. Greatly aided by our participation in the National Science Digital Library, we have cataloged more than 5300 animations, videos, photos, and illustrations. Eight of 10 visits to DNALC.org now arrive at a content atom identified by an Internet search, often with links to related DNALC items. Moving content to *YouTube* and smartphone apps generated new audiences for DNALC multimedia, contributing 15% of total Internet visits in 2011. Views of 190 high-quality animations and videos on our *YouTube* channel increased 150% to 693,917. *3D Brain*, an app adapted from the *Genes to Cognition (G2C) Online* website was downloaded 440,073 times, and the new *Gene Screen* app was downloaded 4888 times.

Lesson 3: Try to Answer the Difficult Question. Every educator and multimedia developer is from time to time faced with the difficult question from a board member or funding agency: “This program is very nice, but can you prove it actually helps students to learn?” In recent years, Congress has asked the same question of the educational grant portfolios of the National Science Foundation (NSF) and National Institutes of Health (NIH). This has led to increasing pressure on principal investigators to go beyond anecdotal reports of teacher satisfaction with new resources to sophisticated studies of how those resources impact students in the classroom.

We accepted this charge in 2011, conducting classroom experiments with 662 high school and college students to see if the DNALC’s *G2C Online* and *Inside Cancer* websites improve science learning. To control for differences between teachers and students, we used a crossover repeated-measures design, in which each student participated as both an experimental and control subject, using a DNA website to learn one topic and using lectures, textbooks, or other websites to learn another topic. Strikingly, scores on quizzes given after each topic were significantly higher when students used *G2C Online* (81% vs. 70%) and *Inside Cancer* (85% vs. 73%). Thus, we now have a practical and supportable answer to that difficult question: an engaging website can potentially increase student learning by about one letter grade!

Lesson 4. Help Distribute Cybertools and Data to a Broader Audience. Science takes place on a continuum between research and education. Traditionally, access to limited data kept most good science far to the research end of the spectrum. Now, the ready availability of nearly unlimited data from high-throughput DNA sequencers—plus powerful bioinformatics analyses from shared servers—promises to shrink the research-education continuum into a single endeavor. 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. We have devoted considerable effort to developing educational resources to help students generate, share, and analyze the same genome data as scientists.

In 1998, we developed the first cyberexperiment to allow students to analyze a short DNA sequence from their own genome, along with the first DNA database and bioinformatics interface for education (*BioServers*). Our interest in community workspaces and bioinformatics culminated in our involvement in the *iPlant Collaborative*, a project to develop a cyberinfrastructure for plant science research. As educational outreach for this project, we are developing a parallel bioinformatics workflow, *DNA Subway* (www.dnasubway.org), for genome analysis and comparison. These projects begin to push bioinformatics mid spectrum, where the battle for advanced cyberliteracy must take place. Here, we all must work hard to make bioinformatics workflows accessible to the legions of bright biologists who are not computer scientists and who do not know one down the hall.

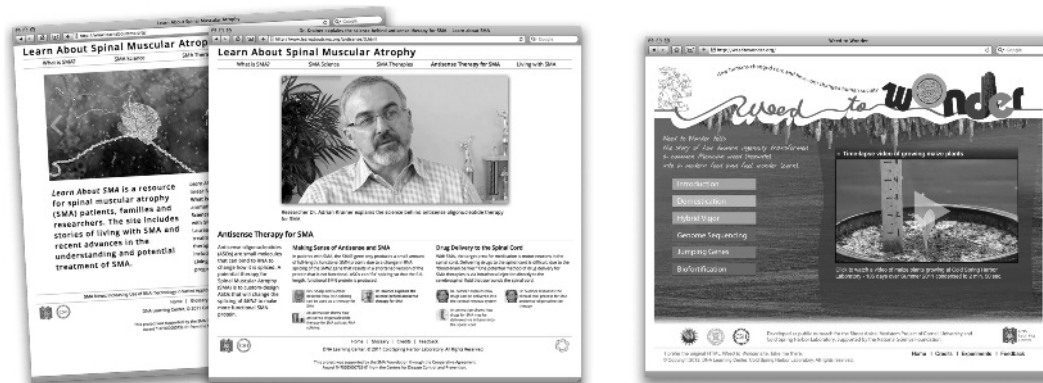
A Trio of New BioMedia Projects

We partnered with the Victor Center for the Prevention of Jewish Genetic Diseases, at Einstein Healthcare Network, to produce a new iPhone and iPad app, *Gene Screen*. The animated app aims

to help people understand that (1) the prevalence of recessive genetic diseases varies among different population groups and (2) healthy members of at-risk groups should consider being screened to see if they are carriers of a disease gene. Interactive Punnett squares update this classic way to calculate how traits are passed from parents to children, and a “slot machine” spins to show carrier frequencies of 19 genetic diseases in Jewish communities versus the general population. An interactive ancestry map highlights recessive genetic diseases that are more common in certain regions of the world. Although the app was specifically designed to alert people to genetic screening, precollege science teachers and students will appreciate this fun way to learn basic genetics.



The Spinal Muscular Atrophy (SMA) Foundation has long supported CSHL researcher Adrian Krainer's work on RNA splicing and molecular approaches to SMA therapies. To coincide with the first clinical trials of a drug based on Dr. Krainer's methods, we developed the Internet microsite *Learn About SMA* as a resource for patients, families, and researchers, funded by the SMA Foundation. A major aim is to explain how emerging therapies attempt to “turn up” production of an essential muscle protein by correcting or compensating for an error in RNA splicing. Interviews with patients and clinicians are complemented by interviews with researchers, including CSHL alumni Philip Sharp and Richard Roberts who shared the Nobel Prize for the discovery of RNA splicing. Animations illustrate the physiological and molecular genetic basis of SMA and emerging therapies. A detailed three-dimensional animation of the mechanism of RNA splicing was produced by Drew Berry, a 2010 McArthur Fellow with whom we collaborated on the award-winning *DNA Interactive* website and the PBS television series “DNA.”



As outreach for an NSF research project on maize growth, with CSHL researcher Marja Timmermans and Cornell researcher Mike Scanlon, we completed development of *Weed to Wonder*. This “e-book” tells the story of how human ingenuity transformed a common Mexican weed (teosinte) into a modern food wonder (maize). Using state-of-the-art software, we created a flexible, *National Geographic*-style magazine that can be ported as an Internet microsite, tablet-enabled application, or printable PDF. The tablet application shows off the real power of the technology, where pages advance by “swiping” and videos automatically expand to play full screen. The work takes readers on a journey from the domestication of maize in Mexico to the development of modern hybrids, genome sequencing, transposons, and direct genetic modification and biofortification. The history of maize research is brought to life through reconstructions of George Shull's and Barbara McClintock's work at Cold Spring Harbor, rare photographs, and links to original publications and artifacts.

As part of the project, we filmed a time-lapse video of the life cycle of maize plants – from emerging cotyledons to harvest, over a period of 105 days. With help from Peter Bommert, Tim Mulligan, and the CSHL facilities staff, we installed a minigarden of six plants on the DNALC roof and automatically recorded numerous clips per day on two video cameras installed behind a Plexiglas screen. The plants weathered the early onset of Hurricane Irene, but they were brought inside for the worst of it. Once the hurricane was past, video capture continued using battery packs for several days until power was restored to the DNALC.



Urban Barcode Project

The *Urban Barcode Project (UBP)* is a science competition to support independent, open-ended investigations using DNA barcoding by New York City (NYC) high school students. Supported by an 18-month grant from the Alfred P. Sloan Foundation, we aim to show that we can quickly develop an infrastructure to support large-scale dissemination of student DNA barcoding in NYC and other sites around the world as outreach for the *International Barcode of Life Project (iBOL)*.

In 2011, we completed development of a robust protocol to extract, amplify, and sequence DNA barcodes from many plant, fungi, and animal species. The experiment is supported by a dedicated Internet microsite, www.DNABarcoding101.org, which includes online and downloadable lab protocols, detailed teacher preparation materials, video podcasts (“vodcasts”), animations, and a news feed. In 2012, the experiment will be published in the DNALC’s forthcoming lab/text *Genome Science* (by CSHL Press) and as a stand-alone kit marketed by the Carolina Biological Supply Company. DNA sequencing is provided at \$3.00 per read by GENEWIZ, with results automatically uploaded to *DNA Subway*.

In addition to this research infrastructure, we also built an *UBP* website to support all aspects of the project (www.urbanbarcodeproject.org), including vodcasts on barcoding and student projects, guidelines for proposal preparation, and management tools for tracking student projects, from submission to completion. During the first 6 months of the year, we did a blitz of promotion, with targeted e-mails to 10,500 NYC teachers and administrators, superintendents, principals, and teachers in NYC public and private high schools, 21,500 e-copies of the DNALC’s *BioBulletin*, and posters and brochures delivered to 150 high schools and 25 universities. Nearly 800 high school teachers, administrators, and researchers attended 19 information sessions, and 128 teachers and mentors attended 18 workshops for training on the DNA barcoding experiment. These 6-hour workshops dovetailed with our existing Howard Hughes Medical Institute (HHMI) teacher-training program.

Our advertising, recruitment, and training strategies worked. After careful review, we accepted 102 of 118 project proposals, meeting our goal of involving 100 teams in the first year of the project. The teams comprise 304 students (including 26% Latino or African American) from 31 pub-

lic and nine private schools across the five boroughs of NYC. Teams are mentored by 36 high school teachers, four graduate students, two postdoctoral fellows, and six university professors. Projects examine biodiversity in parks and public areas (42%), species traded in ethnic markets (28%), food fraud (17%), exotic and invasive species (8%), and public health and disease vectors (5%). To assist with collecting specimens, we coordinated permits and activities with the New York State (NYS) Department of Environmental Conservation and Department of Parks and Recreation. Participating teams have free access to equipment and reagents needed to isolate DNA and amplify the barcode region from their samples. They may check out an equipment footlocker for use at their own school or attend *Open Lab* sessions at *Harlem DNA Lab* and Genspace, a nonprofit citizen science center in Brooklyn. All students have access to a DNALC staff member or trained mentor. Teams will present their study results in poster sessions held in spring 2012. A jury of experts in biodiversity, conservation biology, DNA barcoding technology, and science education will select the top teams based on project originality, creativity, relevance, thoroughness, and scientific merit. Finalists will give oral presentations at a symposium, where teams winning the \$10,000 grand prize and \$10,000 in runner-up prizes will be announced.



iPlant Collaborative

The most obvious driver of plant research is the race to develop higher-yielding plants to feed a burgeoning world population. Aside from more human mouths to feed—world population hit 7 billion in October 2011—there are also more livestock to feed. Increasing wealth in developing countries means that more people can afford western diets where more calories come from meat raised on grain. Global climate change adds new urgency to this age-old problem, and genome scientists are joining forces with plant breeders to help crop plants adapt to regional changes in rainfall and temperature.

The *iPlant Collaborative* is a major NSF project to develop a computer infrastructure to help plant scientists increase global food production in the face of climate change. A consortium of the University of Arizona, University of Texas at Austin, and CSHL, *iPlant* focuses on building computer tools and services to solve two “Grand Challenges” in plant research. *Genotype to Phenotype* aims to predict how genes and the environment work together to influence plant traits. *Tree of Life* works to build a phylogenetic tree that represents the evolutionary relationships of all species of plants. Both efforts are made possible by new technologies, such as next-generation DNA sequencing, which can produce an amount of data equivalent to the human genome in less than a week.

During the year, *iPlant* launched three major legs of its cyberinfrastructure: (1) *Discovery Environment* is a customizable workspace for a variety of data analyses. (2) *Data Store* is a secure place to make large-scale user data available to *iPlant* analysis tools. (3) *Atmosphere* is a personal, customizable computing cloud to run analyses and share projects. With the maturation of the *iPlant* cyberinfrastructure, education, outreach, and training (EOT) is becoming a primary concern of all *iPlant* staff and collaborators.

As lead of the EOT effort, the DNALC lends its expertise in organizing workshops, developing training materials, and building websites and interfaces. During the first half of the year, the DNALC's *BioMedia* Group redesigned the *iPlant* website to streamline navigation and to better convey the project's goals and progress. Vodcasts provide overviews and guided tutorials to acquaint scientists with *iPlant*'s many tools and services. The improved website was relaunched in July with remarkable results: visits increased 64% July–December 2011 (21,881) compared to the same period in 2010 (13,331).

We continued to evolve *DNA Subway* as the educational analog to the *Discovery Environment*. *DNA Subway* is an intuitive bioinformatics platform based on the metaphor of a subway line. Most effort focused on development of the Blue Line for DNA barcode and phylogenetics analyses. The Blue Line includes a number of new web applications that heretofore could only be purchased as stand-alone desktop software. An electropherogram viewer allows users to visualize the peaks that determine DNA sequence “reads,” and a DNA barcode viewer makes it easy to see patterns of single nucleotide polymorphisms (SNPs) between aligned DNA sequences. A consensus builder and editor helps users maximize data from forward and reverse reads. Automatic links to Google images, Wikipedia, and the Encyclopedia of Life provide context to DNA sequence search (BLAST) results. Phylogenetic trees are constructed using both neighboring joining and maximum likelihood methods. Toward the end of 2011, the team began working with the NIH National Center for Biotechnology Information (NCBI) to develop a pipeline for users to submit novel barcode sequences to GenBank.

DNALC staff introduced *DNA Subway* and barcode analysis to more than 300 high school and college educators at workshops conducted at nine locations across the United States. An additional 222 educators learned about *DNA Subway* at short courses and demonstrations at meetings of the American Society of Plant Biologists (ASPB), Botanical Society of America, National Association of Biology Teachers (NABT), National Science Teachers Association (NSTA), *iPlant Collaborative*, and USDA Plant and Animal Genome Research Program.



Howard Hughes Medical Institute

Virtually all students in NYC receive instruction in genetics and biotechnology at two key points in their education: in 8th grade as part of the NYC *Scope and Sequence for Science* and in 9–10th grade in the NYS Regents course, *Living Environment*. Many teachers in the middle grades do not have sufficient training and have very few resources for providing hands-on, inquiry-based labs to make genetics and biotechnology content interesting and relevant for students. Thus, the objective of the HHMI project is to train teachers to use a set of six targeted labs that cover key concepts and techniques within the NYC and NYS curricula: variability and inheritance, DNA structure and isolation, bacterial transformation, protein isolation, DNA analysis and forensics, and analysis of human DNA variations by polymerase chain reaction (PCR).

In 2011, 146 science teachers attended HHMI workshops at the *Harlem DNA Lab*: 128 teachers participated in 44 1-day workshops, and an additional 18 highly qualified teachers participated in the 2-week *Leadership Symposium*. More than three quarters of the trainees were within our primary audience of 8–10th grade teachers. Notably, nearly half of the workshop participants were African American or Hispanic (48%), although they comprise only 14% of teachers nationwide (U.S. Census Bureau, the 2011 Statistical Abstract).

Evaluating pre- and postworkshop surveys of 2011 participants revealed significant knowledge gains for all workshops (pretest mean score $74\% \pm 16$ vs. posttest $81\% \pm 14$; $t_{36} = 5.535$, $P < 0.001$). Follow-up surveys showed that of the 2009 and 2010 program participants, 81% had improved

confidence in teaching labs, and a majority had implemented at least one of the targeted labs (59%) or used the DNALC's online teaching resources (61%) in the last 12 months.

Support of in-class instruction became a crucial focus in 2011. Through a grant from the Richard Lounsbery Foundation, we developed 15 biotechnology footlockers that contain all of the equipment and expendable supplies needed to teach each targeted lab. It took us a little time to figure out why footlocker use was slow in 2010; logistically, there was no way for teachers to get the bulky kits to their schools by public transport and many could not afford the modest restocking fee. Thus, we now use unrestricted funds from the Dana Foundation to pay for restocking and FedEx shipping. A DNALC instructor is also available to help set up the equipment and co-teach the lab activities in school. As a result, footlocker use doubled in 2011, with 2567 students participating in experiments at their schools, 60% of whom were African American or Hispanic.

HHMI program participants are supported by dedicated online resources for each targeted lab. Each *Lab Center* is a virtual classroom set, into which a DNALC staff member enters to make a video introduction. By clicking on various objects on the whiteboard and desk, users can access (1) interactive and PDF versions of the experimental protocol, (2) follow-up activities, (3) scientist interviews, (4) animations, and (5) selected links to related Internet resources. *Lab Center* content was developed and reviewed by six HHMI Teacher Fellows, who are seasoned educators from the New York metropolitan area.

In 2011, we developed the pilot *New York Stories*, a series of vodcasts to highlight research done at New York institutions related to each of the target labs. The pilot production was led by HHMI Teacher Fellow Kathleen Rucker and science teacher David Conneely of Brooklyn International High School. A six-student production team developed a rough script/storyline for bacterial transformation. In parallel with a *BioMedia* videographer, the students filmed themselves with Flip cameras as they performed a transformation experiment at school and then traveled to Columbia University to interview Nobel laureate Dr. Martin Chalfie. Stop-motion animations and intercutting low- and high-resolution footage contributed to an edgy production with an MTV feel.

New National Science Foundation Training Program

Careers in biotechnology increasingly demand a genome-wide perspective that requires students to move comfortably between in vitro experiments at the lab bench and in silico experiments on the computer. In the spring, the DNALC was awarded a grant from the NSF Advanced Technological Education (ATE) Program to help community college faculty move students toward this synthesis. In collaboration with the National Advanced Technological Education Center for Biotechnology (Bio-Link), we presented *Genomic Approaches in Biosciences* Workshops that provided the scientific foundation for biotechnology careers in the genome age. The program focuses on four key technologies—PCR, DNA sequencing, RNA interference (RNAi), and bioinformatics—in three eukaryotic systems: humans, plants, and *Caenorhabditis elegans* (roundworm). Each experiment/bioinformatics module can be integrated into existing courses, provide the basis for new courses, or serve as the foundation for student research projects.

During its 3-year term, the program will reach 288 biotechnology faculty at week-long workshops conducted at 12 community colleges nationwide. In spring, we convened a board of 12 faculty advisors who are involved in all aspects of the program: determining the workshop curriculum, hosting and co-instructing workshops, providing follow-up participant support, and evaluating the program. In the summer, 88 educators participated in workshops conducted in four locations: Gwinnett Technical College (Lawrenceville, Georgia), Madison Area Technical College (Madison, Wisconsin), Shoreline Community College (Shoreline, Washington), and Universidad del Turabo (Gurabo, Puerto Rico). Postworkshop surveys of participants showed gains in concept knowledge and teaching confidence, particularly for DNA barcoding, RNAi, and bioinformatics, and 82% said they would implement the materials in their teaching.

The ATE program makes use of two DNA sequencing projects developed by the DNALC. DNA barcoding, developed for the *iPlant Collaborative* and the *Urban Barcode Project*, is described above. Human mitochondrial DNA sequencing, developed in 1998, allows students to examine a variable DNA sequence from their own genome. Using a kit developed with our collaborator, Carolina Biological Supply Company, students isolate DNA from cheek cells, amplify part of the mitochondrial control region, and send their samples for DNA sequencing. With kits donated by Applied Biosystems, the DNALC provided free DNA sequencing from 1998 through 2010.

Anticipating increased demand for sequencing from three grant-supported programs, we calculated that the cost of commercial sequencing had declined so much by 2011 that it was less than our costs to have a college intern do the lab work! Thus, we contracted with GENEWIZ to provide DNA sequences for the DNALC and affiliated schools for \$3.00 each. This had the effect of improving sequence quality and reducing turnaround time from 2 weeks to 2 days. Under this new paradigm, a record number of sequences were uploaded to DNALC databases. A total of 8436 student samples (7073 mitochondrial control region sequences and 1363 DNA barcodes) were submitted from 110 high schools and 67 colleges and universities.

Nationwide Teacher Training Programs

For more than 25 years, the DNALC has provided cutting-edge lab and computer training for educators at sites around the world. In 2011, 457 high school and college faculty participated in workshops conducted at 19 sites across the United States. These were in addition to the 273 NYC teachers trained with support from HHMI and the Sloan Foundation, where 40% of participants were minorities underrepresented in science (African Americans and Hispanics). Overall, underrepresented minorities composed 27% of 730 educators trained at 76 workshops (1–10 days). An additional 1400 people attended seminars or short workshops at professional meetings, including ASPB, iBOL, NABT, NSTA, International *C. elegans* Meeting, and Plant and Animal Genomes. (For a complete list of training activities and host sites, see the table at the back of this report, “2011 Workshops, Meetings, and Collaborations.”)

In addition to the student experimental studies highlighted in the introduction, we were interested in learning the effects of three teacher training programs that concluded in 2011: *Silencing Genomes*, *Genes to Cognition (G2C) Online*, and *Inside Cancer*. In each case, faculty were surveyed at three time points: preworkshop, postworkshop, and 9–18 months later. This added to more than 20 years of longitudinal DNALC studies tracking the effects of workshop training on classroom teaching behaviors.

Silencing Genomes, funded by the NSF Course Curriculum and Laboratory Improvement (CCLI) Program, introduced faculty to the Nobel-Prize-winning technology of RNAi. The 5-day workshops clearly had their intended effect of increasing hands-on lab experience. Prior to the workshop, only 6% of participants had done labs, but 12–18 months later, 71% had done at least one lab. Remarkably, 20% of educators had students develop custom RNAi vectors, and 43% had students do complementary bioinformatics exercises. Respondents reported doing the new labs with 3926 students and providing classroom lectures on RNAi to 10,053. There was also a marked “train-the-trainers” effect, with workshop participants providing labs to 156 other instructors and lectures to 392 faculty. To support classroom implementation, the DNALC built a collection of *C. elegans* strains and *Escherichia coli* RNAi feeding strains, which are available free-of-charge through the *Silencing Genomes* website. A formatted e-mail allows educators to request strains for specific dates. Since launching the service in August 2007, we have filled orders for more than 2800 strains, which educators reported using with more than 16,000 students.

Likewise, the majority of participants in 1-day workshops on *G2C Online* and *Inside Cancer* reported improved understanding and use of the multimedia materials to scaffold instruction in a variety of classes.

	G2C Online	Inside Cancer
<i>Reported Good to Very Great Improvement in</i>		
Understanding of topic	88%	54%
How to teach the topic	90%	61%
Had used website with one or more classes since workshop	86%	97%
<i>Classes in which Materials Were Implemented</i>		
General Biology	42%	50%
Honors/AP Biology	19%	33%
Genetics/Biotechnology	14%	27%
Anatomy and Physiology	14%	20%
General/AP Psychology	19%	N/A
<i>How Website Was Used</i>		
As a source of information	70%	82%
As a source of new teaching materials	63%	64%
To read scientific articles	52%	55%
For student projects	48%	37%
To teach directly in the classroom	39%	45%

Dolan and DNALC West Student Programs

This year, we served 25,836 student participants in both in-school instruction programs and field trips to the Dolan and *West* facilities. Participation of 2800 students from underserved Long Island and Queens school districts was sponsored by grants from Bank of America and the National Grid Foundation. This included our continuing collaboration with Brentwood Union Free School District, where we provided genetic engineering labs for 6–8th grade classes participating in the first district-wide science fair. The entire world was inspired when Samantha Garvey, a former participant in DNALC labs at Brentwood, overcame homelessness to become a semifinalist in the Intel Science Competition.

The summer workshop season was record-breaking in every sense. Topping the previous record from 2009, more than 1000 students participated in 44 week-long camps held at six locations on Long Island and NYC: Dolan DNALC, DNALC *West*, Stony Brook University, Chapin School, and Trinity School. Among the summer campers were 19 students from Beijing No. 166 High School, the first specialized school of life sciences in the Chinese capital. The students spent three weeks at the DNALC, progressing from classical genetics, to bacterial cloning, to human and plant genomics. The summer study culminated in a book signing and Q&A session with CSHL's own Nobel laureate, James Watson, and a field trip to the Human Origins exhibit at the American Museum of Natural History (AMNH). Anticipating a growing exchange program with Beijing 166 and other schools in China, we proceeded with plans to develop a fourth teaching lab at the Dolan DNALC.



Students, teachers, and administrators from Beijing No. 166 pose with DNALC staff.

We struggled to save the last week of summer camps in the aftermath of a visit by Hurricane Irene, which took out power for more than 350,000 homes and businesses on Long Island. The Monday following the storm, we returned to find power off, the basement flooded, and more than 50 families arriving with camp registrants. After meeting parents at the curb and communicating a hurried plan, we spent the rest of the day moving three labs' worth of equipment and supplies to

teaching spaces on the CSHL campus. By Tuesday morning, all was in place to restart the camps, with greeters directing parents to locations in Beckman and Delbrück labs, and 95% of registered campers turning up.

Monthly *Saturday DNA!* sessions drew 219 participants, with parents and grandparents joining their children to learn about superbugs, dinosaurs, and mitochondrial DNA. The annual *Great Moments in DNA Science* seminar series drew 162 top Long Island high school students for presentations on current biological research. CSHL researcher Dr. Andrea Eveland explained how she combines classical genetics with cutting-edge technologies to understand the molecular mechanisms that control flowering in maize. Dr. Damon Love, a postdoctoral researcher at Weill Cornell Medical College, discussed how RNAi can potentially silence genes involved in the progression of liver cancer. Dr. Benoit Boivin from the Tonks lab at CSHL explained how cell physiology is affected when oxygen reacts with a class of enzymes called protein tyrosine phosphatases.

Harlem DNA Lab

With continued core support from the Dana Foundation and student scholarship funding from the William Townsend Porter Foundation, in 2011 the *Harlem DNA Lab* hosted 1849 NYC public and private school students, 60% of whom were either African American or Hispanic. We also provided intensive enrichment to students from two schools housed with us in the John S. Roberts (JSR) Educational Complex: 12th graders from the Coalition School for Social Justice participated in three biotechnology laboratories, and 6–8th graders from MS45 enjoyed three introductory genetics laboratories. In the spring, we participated in the World Science Festival, hosting children at an outdoor DNA extraction booth in Washington Square Park. *Harlem DNA Lab* also became the focal point for our *Urban Barcode Project*, hosting information and training sessions for educators and providing kits and *Open Lab* days for teams to conduct their experiments.

The Charter Membership Program continued in 2011 with Chapin School and Trinity School. The program provides intensive support to independent schools wishing to develop a sequenced program of accelerated science opportunities for students and teachers. Each school receives customized instruction that includes professional development for science teachers, field trips to DNALC facilities, in-school lab visits, and on-site summer camps taught by DNALC instructors. As a result of this successful partnership, we worked with Chapin School's Head of School Patricia Hayot to develop an extensive program of DNA camps for students from NYC independent schools to be held at Chapin in summer 2012.

Although we have managed to stay afloat against a current of change within the NYC public school system, the continued devolution of the Department of Education (DOE) is a source of unease. The JSR Educational Complex is emblematic of continued reorganization and administrative shuffling within the DOE, with two schools phased out and two new schools phased in during our tenancy. Student discipline and security are recurring concerns. HHMI support has helped us prove that a small, focused science institution can indeed have a substantial impact on a megalithic school system. However, at this point, it seems imperative that we establish a stand-alone facility in Manhattan, where we can continue to expand teacher and student opportunities to participate in the gene age.



Visitors to our booth at the World Science Festival viewing cells and extracting DNA.

Partnerships and Graduate Training

We continued our partnership with Cold Spring Harbor High School (CSHHS) to offer *Molecular and Genomic Biology*. This college-level level course is scheduled during the last two class periods and is coconstructed by DNALC staff members and CSHHS biology and research teacher, Jaak Raudsepp. The course emphasizes hands-on experimentation, critical thinking, and independent projects across a range of biological systems. The sixth class started in the fall with a unit on gene function in the roundworm *C. elegans*. CSHL Watson School of Biological Sciences (WSBS) graduate student Colleen Carlston helped the CSHHS students set up a genetic screen that identified three new genes that affect RNAi function. The class then moved onto projects using DNA barcoding to identify wild plants and animals, pets, and food products from grocery stores.

A project on three-dimensional protein modeling, was conducted in collaboration with the Center for Science and Mathematics Education (CESAME) at Stony Brook University. The students used data from primary research papers to identify important parts of proteins involved in the cell cycle, and drugs that interact with them. They then used three-dimensional modeling software to highlight key atoms involved in molecular interactions. The modified structure files were sent to CESAME, where detailed atomic resolution models of the proteins were manufactured on a state-of-the-art prototyping three-dimensional printer. This machine is essentially a laser printer that layers droplets of polymer resin in three dimensions to build a detailed molecular model. Students will present their models and explanatory posters at the May 2012 CSHL meeting, *The Cell Cycle*. (A highlight of last year's course was students' poster presentations at the CSHL *Biology of Cancer* meeting, where the audience included Nobel laureate Robert Weinberg.)

As part of our expanding collaboration with CESAME, Multimedia and Evaluation Manager Amy Nisselle, Ph.D. was appointed adjunct faculty at Stony Brook University. Calling on her academic background in public health, education, and medical research, Amy coadvisees CESAME doctoral program candidates on thesis projects. Two candidates are helping to evaluate the NSF ATE *Genomic Approaches in Biosciences* program: DNALC Teacher Fellow Caren Gough is investigating the program's impact on teachers' pedagogical beliefs and practices, and Robin Tornabene is examining its socioscientific effects. Jaak Raudsepp of CSHHS is tracking the long-term career trajectories of CSHL *Partners for the Future* alumni.

In our collaboration with the WSBS, graduate students do a 3-month rotation in science instruction. Pairs of students work with a seasoned DNALC instructor to master the presentation of genetics labs to middle and high school students. During the first phase of training, student teams observe the DNALC instructor in the classroom and organize a lesson plan that integrates their own perspectives. The second phase is coteaching, during which graduate students instruct the lab portion of the class. DNALC instructors provide constructive critique in preparation of the third and final phase: independent teaching. Upon completion of both middle and high school teaching rotations, WSBS students deliver three additional lessons to demonstrate mastery of instruction and classroom management skills, which are useful for teaching at any level.

We applied our expertise in graduate education to a collaboration with the New York Academy of Sciences (NYAS). One of the oldest scientific institutions in the United States, the NYAS is now based in the new World Trade Center. The DNALC provided 6 hours of lab instructional training to 100 graduate students and teachers who serve as NYAS mentors in after-school programs for NYC students in grades K–12. The mentors learned to deliver several popular DNALC labs, including the *DNA Extraction from Banana* and *Baggie Cell Model*.

We also continued our long-term collaboration with the Singapore Ministry of Education, hosting six Singaporean teachers for 2-week attachments. In July, high school biology teachers Ms. Leo Minyin and Mr. Yang Wenjun participated in the HHMI Leadership training at the *Harlem DNA Lab*. In November, primary teachers Mrs. Thia Woon Ling, Ms. Eileen Chin, Mdm. Wee Shu Yi, and Mr. Azman bin Mohammed Dali participated in student labs and small workshop sessions fo-

cused on the *Fun with DNA* and *World of Enzymes* curricula. All teachers are required to author formal lesson plans and share new teaching methods with teachers at their home schools.

Staff and Interns

2011 saw a number of significant staff changes, with bittersweet partings and promises of new challenges. Uwe Hilgert wound up 10 years' service to the DNALC and CSHL when he returned to the University of Arizona to become director of outreach for the Bio5 Institute. Reared on a riverboat in Germany, Uwe received a Ph.D. from the Max-Planck Institute for Plant Breeding in Cologne and then conducted postdoctoral research at the University of Arizona. Uwe started at the DNALC in 2000 as a high school instructor, then quickly developed the DNALC's bioinformatics capability under an HHMI grant. As Assistant Director, beginning in 2005, Uwe assumed responsibility for all of the DNALC's professional development activities, which each year involved planning several dozen events around the country. After a year's special assignment as Assistant Dean of the WSBS, where he helped ease transition to new leadership, Uwe returned to the DNALC in 2008 to spearhead the outreach component of the *iPlant Collaborative*. His attention to detail and ability to carry out complex planning was critical during a period when DNALC's teacher training increased fivefold. Although he will be greatly missed, we continue to collaborate on a weekly basis.



Uwe Hilgert and Sheldon McKay

Ileana Rios left her position as *Harlem DNA Lab* manager for a teaching position at the prestigious Trinity School, where her son is a student. Ileana was the perfect person to initiate our effort to bring high-level science to underrepresented students in NYC. She was born and attended elementary school only blocks away from our facility in Harlem, received a bachelor's degree in biology from Barnard College and Ph.D. in molecular biology from City University of New York (CUNY). Her background and work at *Harlem DNA Lab* will come in handy as she develops a molecular genetics elective at Trinity, and as several teams of her students participate in the *Urban Barcode Project*.

Under normal circumstances, the loss of two key staff would have been traumatic, but we were lucky to have two fantastic replacements waiting in the wings. Uwe's loss was compensated by a reciprocal move back to CSHL by Sheldon McKay, who had moved from Lincoln Stein's lab to the *iPlant Collaborative* at the University of Arizona. Sheldon brings high-level bioinformatics expertise to the DNALC. Sheldon has a bachelor's and master's degrees in genetics from the University of British Columbia and a Ph.D. in evolutionary genetics from Simon Fraser University. His first task will be to build "Green Line" for our *DNA Subway*; this workflow will provide a simple interface to analyze RNA data sets from next-generation sequencers.

New *Harlem DNA Lab* Manager Melissa Lee has an undergraduate degree in biology from Johns Hopkins and a master's degree in science education from CUNY. Her work experience includes managing a molecular genetics lab at New York University and, for the last several years, teaching at Marie Curie Science High School in the Bronx. As a student growing up in the Bronx, Melissa's interest in genetics was sparked when she attended a *DNA Science* course taught by the DNALC at the AMNH.

At the same time, we recruited Oscar Pineda-Catalan as *Urban Barcode Project* Manager. A native of Mexico City, Oscar has an undergraduate degree in biomedical basic research and a master's degree in urban studies from the University of Mexico. Teaching biology and human anatomy and physiology in a Mexico City high school inspired him to pursue a career encompassing both scientific research and education. Under a Fulbright Fellowship, he completed a Ph.D. in ecology and

conservation biology at Columbia University, where his thesis examined threatened turtles of the Amazon River in Ecuador. George Amato graciously allowed him to keep an office at the Sackler Institute for Comparative Genomics at the AMNH, where he most recently did postdoctoral research. This significantly strengthened our collaboration with this important institution.

Our outreach effort was further bolstered with two incredible staff members from Europe. A native of Austria, Dr. Christine Marizzi divides her time between the *Harlem DNA Lab* and DNALC *West*, where she is the new Lab Manager. After receiving a Ph.D. in genetics from the University of Vienna,

Christine developed youth education programs with *wienXtra* and was an instructor at *Vienna Open Lab*, a long-term licensee of DNALC intellectual property. Dr. Alexandra Manaia is working on the *UBP* in fulfillment of the final phase of a Fulbright Fellowship and master's degree in international education development at Columbia University. After receiving a Ph.D. in developmental biology from Paris 7 University, she worked as science education officer at the European Molecular Biological Laboratory in Heidelberg, where Dave Micklos met her when working as an advisor to a Europe-wide teaching training program.

The DNALC bid farewell to middle school instructor Jennifer Aiello in 2011. Jen started at the DNALC as a high school intern in 2002 and worked her way up to instructor after completing a bachelor's degree in Forensic Science in 2009 from Long Island University. In November, Jen accepted a position with the NYC Police Department to pursue a career in criminalistics and forensics. We also said goodbye to videographer Todd Rocheford, who will use his experience developing *New York Stories* and *UBP* videos in his new consultancy.

Our internship program continued to draw some of Long Island's most talented high school and college students, engaging them in science research and providing practical laboratory experience. Our new high school interns were Kathryn Bellissimo (Walt Whitman), Cyril Danielkutty (Harborfields), Alexa DeAngelis (St. Anthony's), Frieda Haerter, Julie Hemphill, Eun Sung Suh (John Glenn), Paras Patel (Half Hollow Hills East), Anna Saum (home school), and Gianna Torre (Wan-tagh). The new hires joined a dedicated group of returning interns: Jack Greenfield (Oyster Bay), Devika Gupta (Farmingdale), Jueng Woen Kim (Hauppauge), and Young Joon Suh (John Glenn). During the summer, we welcomed four new interns to assist with DNALC *West* camps: Eliana and Juliet Jacobson (Hebrew Academy of Nassau County), James Polke (Regis), and Aman Sharma (Hericks). We bid farewell to a number of high school interns as they left for their freshman year at college: Laura Bergsten (Dartmouth), George Economou, Lindsay Hochberg, David Streitman (Cornell), Max Vaysman (SUNY Geneseo), and Pamela Wax (Northwestern).

College interns supervise high school students, assist with summer camps, and work on specialized projects, including fulfilling faculty requests for RNAi targeting vectors. Returning college interns in 2011 were David Dopfel, Lina-Mari Varghese (Stony Brook University), Katherine Villalon (John Jay University), and Sara Weinclaw (University of Maryland). City-dwellers Arielle Scardino (City College of New York) and Sulaiman Usman (New York Institute of Technology) assist at *Harlem DNA Lab* and with the *UBP*.

Many DNALC interns are involved in independent research projects and compete in state and national science competitions: Alexa DeAngelis studied visual and spatial short-term memory loss, Young Joon Suh studied bioremediation of oil spills using cyanobacteria, Eun Sung Suh studied effects of antibiotics on *C. elegans*, Katherine Villalon used random amplified polymorphic DNA (RAPD) to detect genomic instability in lung cancer, and David Dopfel examined longevity genes



Oscar Pineda-Catalan, Melissa Lee, Alexandra Manaia, and Christine Marizzi.

in *C. elegans*.

We also welcomed two *BioMedia* college interns in 2011. Mara Smith is completing a degree in neuroscience and science journalism at Brown University. Under a Royce Fellowship, she assisted with the development of the *Learn About SMA* Internet microsite. Anne Burlet-Parendel returned to CSHL in 2011 after studying neural stem cells in the Grisha Lab as part of her master's in Genetics, University Denis Diderot, Paris, in 2010. In preparation for starting a Master's of Science Communication at the University Louis Pasteur in Strasbourg, Anne assisted with several projects and inventoried DNALC lab instructional assets.

Expert Advisors and Corporate Support

The DNALC benefits from a Corporate Advisory Board (CAB) that focuses on fundraising from the Long Island business community. Under the guidance of development staff member Karen Orzel since 2005, the CAB golf outing and annual fund have contributed more than \$200,000 per year to DNALC operations. Also during that time, CAB members Laurie Landau, Eddie Chernoff, Peter and Dori Tilles, Pall Corporation, and OSI Pharmaceuticals provided major endowment gifts.

Over the years, the CAB has operated in parallel with the CSHL Association. This group of "friends of the Lab" has raised annual funds for CSHL since the 1920s. To unify local fund raising and foster a greater sense of common purpose, the CAB and CSHL Association annual funds were merged in 2011. Although the two organizations will continue to be managed by separate boards, the unrestricted funds they raise will support both the research and education missions of CSHL.

2011 Workshops, Meetings, and Collaborations

January 15	HHMI Professional Development, <i>Detecting Genetically Modified Organisms</i> Workshop, <i>Harlem DNA Lab</i>
January 15–19	Plant and Animal Genome XIX Conference, Town and Country Convention Center, “DNA Subway: The Fast Track to Gene Annotation,” San Diego, California
January 21–22	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, Florida A&M University, Tallahassee, Florida
January 22	Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York <i>Saturday DNA!</i> “Mitochondrial DNA—Mom’s Legacy,” DNALC
January 26–28	NSF 2011 Course, Curriculum, and Laboratory Improvement—Transforming Undergraduate Education in Science (CCLI-TUES) Conference, Washington, D.C.
January 29	Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York
February 4	Site visit by Christine Marizzi, Max F. Perutz Laboratories, Vienna, Austria HHMI Professional Development, <i>DNA Structure and Isolation</i> Workshop, <i>Harlem DNA Lab</i>
February 5	HHMI Professional Development, <i>DNA Structure and Isolation</i> Workshop, <i>Harlem DNA Lab</i>
February 8	Site visit by Wang Lei, Zhu Yan, and Li Zhenghua, Beijing No. 166 High School, Beijing, China
February 12	HHMI Professional Development <i>Discovering the Urban Environment</i> Workshop, New York Academy of Science, New York
February 18–20	Science Without Borders, The American Association for the Advancement of Science Meeting, “Search Engine Optimization to Increase Audiences for Online Science Education,” Washington, D.C.
February 25–26	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, University of Arizona, Tucson
February 26	<i>Saturday DNA!</i> “Dino DNA!” DNALC HHMI Professional Development, <i>Variability and Inheritance</i> Workshop, <i>Harlem DNA Lab</i>
March 8	Site visit by Father James Williams and John Westerman, Chaminade High School, Mineola, New York
March 8–9	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, City College of San Francisco, California
March 11–12	National Science Teachers Association 2011 National Conference on Science Education, “Barcoding Plants,” “Frontiers in Genomics,” “RNAi/CBSC,” “DNA Subway,” “Iceman,” “Lab Center,” and “CSI,” San Francisco, California
March 12	HHMI Professional Development, <i>DNA Transformation and Protein Isolation</i> Workshop, <i>Harlem DNA Lab</i> <i>Urban Barcode Project</i> Information Session, New York Academy of Sciences, New York
March 19	<i>Urban Barcode Project</i> Information Session, <i>Harlem DNA Lab</i>
March 21–24	Joint Genome Institute User Meeting, Walnut Creek, California
March 25	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i>
March 26	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i> <i>Saturday DNA!</i> “Recovering the Romanovs,” DNALC <i>Urban Barcode Project</i> Information Session, The Rockefeller University, New York
April 2	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i> <i>Urban Barcode Project</i> Information Session, SCONYC Conference, Stuyvesant High School, New York
April 8	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 1</i> Workshop, <i>Harlem DNA Lab</i>
April 9	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 1</i> Workshop, <i>Harlem DNA Lab</i> <i>Urban Barcode Project</i> Information Session, American Museum of Natural History, New York
April 15–16	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, North Carolina A&T State University, Greensboro
April 16	<i>Saturday DNA!</i> “Milky Menace,” DNALC
April 27	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
April 30	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
April 30–May 3	NSF ATE <i>Genomic Approaches in Biosciences</i> , Advisory Board Meeting, CSHL
May 5	<i>Great Moments in DNA Science</i> Honors Seminar: “Sowing the Next-Generation ‘Green Revolution’: Genetics and Genomics of Maize Development,” Andrea Eveland, CSHL, DNALC
May 6	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 2</i> Workshop, <i>Harlem DNA Lab</i>
May 6–7	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, Bowie State University, Maryland
May 7	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 2</i> Workshop, <i>Harlem DNA Lab</i>
May 8–12	National Institutes of Health Science Education Partnership Award Principal Investigators Conference, “Nationwide Dissemination of <i>Inside Cancer</i> ,” Seattle, Washington
May 10	Site visit by Leo Brizuela and Jim Lynch, Agilent, Santa Clara, California <i>Great Moments in DNA Science</i> Honors Seminar, “A Gene Silencing Approach to Control the Development of Liver Cancer Cells,” Damon Love, Weill Cornell College of Medicine, New York, DNALC
May 12	Site visit by Leo Brizuela, Agilent, Santa Clara, California <i>Urban Barcode Project</i> Information Session, New York Academy of Sciences, New York

May 14	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
May 18	Science Coordinators Network Meeting, Dowling College, Oakdale, New York
May 21	<i>Saturday DNA!</i> “Personalized Medicine,” DNALC
May 26	<i>Great Moments in DNA Science</i> Honors Seminar, “How Much Is too Much? Tracking Down Oxygen-Dependent Modifications in Normal and Diseased Cells,” Benoit Boivin, CSHL, DNALC
June 4	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
June 4–5	World Science Festival, “ <i>Harlem DNA Lab</i> ,” and “ <i>DNA Subway</i> ,” New York
June 6–10	Teacher Professional Development Workshop, The Chapin School, New York
June 7	18th Annual Golf Outing, Piping Rock Club, Locust Valley, New York
June 10	NSF Shoot Apical Meristem Meeting, CSHL
June 10–11	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, Canisius College, Buffalo, New York
June 11	<i>Urban Barcode Project</i> Training Session, Genspace, Brooklyn, New York
June 13–17	<i>DNA Science</i> Workshop, Trinity School, New York <i>Fun with DNA</i> Workshop, The Chapin School, New York <i>Fun with DNA</i> Workshop, Trinity School, New York <i>Human Genomics</i> Workshop, The Chapin School, New York <i>World of Enzymes</i> Workshop, The Chapin School, New York
June 16	Site visit by Gregory Crawford, University of Notre Dame, Indiana
June 18	<i>Saturday DNA!</i> “Express Yourself!” DNALC
June 20–24	NSF ATE Professional Development, <i>Genomic Approaches in Biosciences</i> Workshop, Gwinnett Technical College, Lawrenceville, Georgia
June 22–26	18th International <i>C. elegans</i> Meeting, University of California, Los Angeles
June 27–July 1	World Conference on Educational Multimedia, “Novel Networked Navigation: A Case Study of a Genetics Education Internet Site,” Lisbon, Portugal NSF ATE Professional Development, <i>Genomic Approaches in Biosciences</i> Workshop, Shoreline Community College, Washington <i>DNA Science</i> Workshop, DNALC <i>Fun with DNA</i> Workshop, DNALC <i>Fun with DNA</i> Workshop, DNALC West <i>World of Enzymes</i> Workshop, DNALC
July 1	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
July 5–8	<i>Fun with DNA</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC <i>Plant Genomics</i> Workshop, DNALC <i>World of Enzymes</i> Workshop, DNALC West
July 5	HHMI Professional Development, <i>DNA Structure and Isolation</i> Workshop, <i>Harlem DNA Lab</i>
July 6	HHMI Professional Development, <i>Variability and Inheritance</i> Workshop, <i>Harlem DNA Lab</i>
July 7	HHMI Professional Development, <i>DNA Transformation and Protein Isolation</i> Workshop, <i>Harlem DNA Lab</i>
July 7–8	NSF <i>iPlant Collaborative</i> Professional Development, <i>Genomics in Education</i> Workshop, Washington University, St. Louis, Missouri
July 8	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i>
July 9–10	Botanical Society of America, “DNA Subway,” and “DNA Barcoding,” St. Louis, Missouri
July 11–15	<i>DNA Science</i> Workshop, DNALC <i>DNA Science</i> Workshop, DNALC West <i>Human Genomics</i> Workshop, Central Islip <i>Human Genomics</i> Workshop, DNALC <i>World of Enzymes</i> Workshop, DNALC
July 11	HHMI Professional Development, <i>DNA Transformation and Protein Isolation</i> Workshop, <i>Harlem DNA Lab</i>
July 12	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i>
July 13	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 1</i> Workshop, <i>Harlem DNA Lab</i>
July 14	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 2</i> Workshop, <i>Harlem DNA Lab</i>
July 15	HHMI Professional Development and <i>Urban Barcoding Project</i> Training Session, “DNA Barcoding,” <i>Harlem DNA Lab</i>
July 18–22	<i>Fun with DNA</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC West <i>Silencing Genomes</i> Workshop, DNALC
July 18–29	HHMI Professional Development, Leadership Symposium, <i>Harlem DNA Lab</i>
July 25–29	NSF Professional Development, <i>Silencing Genomes</i> Workshop, DNALC <i>Forensic Detectives</i> Workshop, DNALC

July 25–Aug. 12	<i>Genetic Horizons</i> Workshop, DNALC West <i>Introduction to Genetics and Biochemistry, DNA Science, and Genome Science</i> Workshops, Beijing No. 166 High School, DNALC
July 26	<i>Learn About Spinal Muscular Atrophy</i> interviews with Phil Sharp, Massachusetts Institute of Technology, Cambridge, and Richard Roberts, New England BioLabs Inc., Ipswich, Massachusetts
July 29	HHMI Professional Development and <i>Urban Barcoding Project</i> Training Session, “DNA Barcoding,” <i>Harlem DNA Lab</i>
August 1–5	<i>Fun with DNA</i> Workshop, DNALC West <i>Green Genes</i> Workshop, DNALC <i>World of Enzymes</i> Workshop, DNALC
August 1	HHMI Professional Development, <i>DNA Structure and Isolation</i> Workshop, <i>Harlem DNA Lab</i>
August 2	HHMI Professional Development, <i>Variability and Inheritance</i> Workshop, <i>Harlem DNA Lab</i>
August 3	HHMI Professional Development, <i>DNA Transformation and Protein Isolation</i> Workshop, <i>Harlem DNA Lab</i>
August 4	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i>
August 5	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 1</i> Workshop, <i>Harlem DNA Lab</i> <i>Urban Barcode Project</i> Training Session, New York Hall of Science, Queens, New York
August 8	HHMI Professional Development, <i>DNA Transformation and Protein Isolation</i> Workshop, <i>Harlem DNA Lab</i> American Society of Plant Biologists Annual Conference, “DNA Subway,” Minneapolis, Minnesota
August 8–12	NSF ATE Professional Development, <i>Genomic Approaches in Biosciences</i> Workshop, Universidad del Turabo, Gurabo, Puerto Rico <i>Genetic Horizons</i> Workshop, DNALC <i>World of Enzymes</i> Workshop, DNALC <i>World of Enzymes</i> Workshop, DNALC West
August 9	HHMI Professional Development, <i>DNA Analysis and Forensics</i> Workshop, <i>Harlem DNA Lab</i>
August 10	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 1</i> Workshop, <i>Harlem DNA Lab</i>
August 11	HHMI Professional Development, <i>PCR and Human DNA Variation, Part 2</i> Workshop, <i>Harlem DNA Lab</i>
August 12	HHMI Professional Development, <i>DNA Barcoding</i> Workshop, <i>Harlem DNA Lab</i> <i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i> <i>Learn About Spinal Muscular Atrophy</i> interviews with Darryl De Vivo, Columbia Medical Center, and SMA patients and families, New York
August 15–19	NSF ATE Professional Development, <i>Genomic Approaches in Biosciences</i> Workshop, Madison Area Technical College, Wisconsin <i>DNA Science</i> Workshop, DNALC <i>DNA Science</i> Workshop, Stony Brook University, New York <i>DNA Science</i> Workshop, DNALC West <i>Fun with DNA</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC
August 16	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
August 19	Site visit by Maryann Martone, Spinal Muscular Atrophy Foundation, New York
August 22–26	<i>DNA Science</i> Workshop, DNALC <i>Fun with DNA</i> Workshop, DNALC <i>Genome Science</i> Workshop, Stony Brook University, New York <i>Human Genomics</i> Workshop, DNALC <i>Human Genomics</i> Workshop, DNALC West
August 23	<i>Urban Barcode Project</i> Training Session, Genspace, Brooklyn, New York
August 26	Site visit by Pat Hayot, Michael Maloy, and Jill Hirsch, The Chapin School, New York
Aug. 29–Sept. 2	<i>DNA Science</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC <i>Green Genes</i> Workshop, DNALC West <i>World of Enzymes</i> Workshop, DNALC
September 1	<i>Urban Barcode Project</i> Information Session, New York Botanical Garden, Bronx, New York
September 7	<i>Urban Barcode Project</i> Information Session, Richard Gilder Graduate School, American Museum of Natural History, New York
September 16	<i>Urban Barcode Project</i> Information Session, Trinity High School, New York
September 17	<i>Urban Barcode Project</i> Promotion at Maker Faire, New York Hall of Science, Queens, New York Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York
September 19	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>
September 21	<i>Urban Barcode Project</i> Information Session, The Gateway Institute, New York <i>Urban Barcode Project</i> Information Session, Brooklyn Bridge Park, Brooklyn New York
September 23	<i>Urban Barcode Project</i> Information Session, American Museum of Natural History, New York
September 26	<i>Urban Barcode Project</i> Training Session, <i>Harlem DNA Lab</i>

- September 26–28 Site visit by Tony Chiovitti, Gene Technology Access Centre, Melbourne, Australia
- September 28 *Urban Barcode Project* Information Session, Trinity High School, New York
- October 1 *Urban Barcode Project* Training Session, *Harlem DNA Lab*
- October 3 Site visit by James Bono, Buck Koonce, and Camille Bibeau, Lawrence Livermore National Laboratory, Livermore, California
- October 5 *Urban Barcode Project* Information Session, The River Project, New York University, New York
- October 6 Pandora “Town Hall” Discussion and Reception, DNALC
Urban Barcode Project Information Session, Columbia Secondary School for Mathematics, Science and Engineering, New York
- October 7 Site visit by Kim Kerns and Katya Lanfant, Cablevision, New York
- October 8 *Urban Barcode Project* Training Session, *Harlem DNA Lab*
- October 11–12 NSF *iPlant Collaborative* Professional Development, *Genomics in Education* Workshop, University of California, Riverside
- October 12 *Saturday DNA!* “Superbugs Uncovered,” DNALC
Urban Barcode Project Information Session, Graduate Center, City University of New York, New York
- October 12–15 NABT Professional Development Conference, “DNA Barcoding in Your Classroom,” “Silencing Genomes,” “RNAi/CSBC,” “DNA Subway,” “DNA Barcoding,” and “Evaluation of Biology Teaching Resources,” Anaheim, California
- October 14 *Urban Barcode Project* Information Session, The Urban Assembly, New York
HHMI Professional Development, *Variability and Inheritance* Workshop, *Harlem DNA Lab*
- October 15 HHMI Professional Development, *Variability and Inheritance* Workshop, *Harlem DNA Lab*
- October 21 HHMI Professional Development, *DNA Transformation and Protein Isolation* Workshop, *Harlem DNA Lab*
- October 22 HHMI Professional Development, *DNA Transformation and Protein Isolation* Workshop, *Harlem DNA Lab*
- October 24 Site visit by Ania Wiczorek, University of Hawaii, Manoa, Hawaii
- October 25 Site visit by Mathias Schmitt, ARTE, Strasbourg Cedex, France
- October 26–28 NSF ATE Principal Investigators Conference, “Developing Leaders in Biosciences,” Washington, D.C.
- October 27 *Urban Barcode Project* Information Session, Brooklyn Technical High School, Brooklyn, New York
- October 28–29 NSF *iPlant Collaborative* Professional Development, *Genomics in Education* Workshop, Arnold Arboretum of Harvard University, Roslindale, Massachusetts
- November 1 *Urban Barcode Project* Information Session, Department of Education, New York
- November 3–4 Site visit by Shannon Oliver, *iPlant Collaborative*, Tucson, Arizona
- November 5 *Urban Barcode Project* Training Session, Genspace, Brooklyn, New York
- November 8 HHMI Professional Development, *DNA Structure and Isolation* Workshop, *Harlem DNA Lab*
HHMI Professional Development, *DNA Structure and Isolation* Workshop, Genspace, Brooklyn, New York
- November 10 Criminal Courts Bar Association of Nassau County, *DNA Analysis and Forensics* Workshop, Reception, and “DNA—Nothing to Fear,” Eric Carita, Forensic DNA Consultant, DNALC
- November 11 *Urban Barcode Project* Training Session, *Harlem DNA Lab*
- November 11–12 NSF *iPlant Collaborative* Professional Development, *Genomics in Education* Workshop, University of Lone Star College, Kingwood, Texas
- November 12 *Saturday DNA!* “Gram-tastic!” DNALC
- November 14 *Urban Barcode Project* Information Session, Benjamin C. Cardozo High School, New York
- November 15–16 NSF *iPlant Collaborative* Professional Development, *Tools and Services* Workshop, National Evolutionary Synthesis Center, Durham, North Carolina
- November 16 Site visit by Siobhan McKenna, Agilent, Santa Clara, California
Learn About Spinal Muscular Atrophy interview with Charlotte Sumner, The Johns Hopkins Hospital, Baltimore, Maryland
- November 17–18 National Human Genome Research Institute (NHGRI) Genomic Literacy Workshop, “Limited Effects and Genome Education in the Digital Age,” Rockville, Maryland
- November 18 HHMI Professional Development, *DNA Analysis and Forensics* Workshop, *Harlem DNA Lab*
- November 19 HHMI Professional Development, *DNA Analysis and Forensics* Workshop, *Harlem DNA Lab*
- Nov. 28–Dec. 10 Singapore Primary Teachers Attachment, DNALC
- November 30 NSF *iPlant Collaborative* Professional Development, *Tools and Services* Workshop, CSHL
- Nov. 30–Dec. 2 International Barcode of Life Conference, “*Urban Barcode Project*: A Scalable Infrastructure for IBOL Outreach,” Oaks Embassy, Adelaide, Australia
- December 1 Site visit by Suzana Dobre, Mircea Miclea, and Roxana Vitan, Romanian-American Foundation, Bucharest, Romania
- December 8 Site visit by Amanda Dubrowski, Bard College, Annandale on Hudson, New York
- December 9 HHMI Professional Development, *PCR and Human DNA Variation, Part 1* Workshop, *Harlem DNA Lab*
- December 10 *Saturday DNA!* “Mendelian Inheritance,” DNALC
HHMI Professional Development, *PCR and Human DNA Variation, Part 1* Workshop, *Harlem DNA Lab*
- December 14 Site visit by Alex Wolfe, Second Nature Toys, New York

Sites of Major Faculty Workshops 1985–2011

Key:	<i>Middle School</i>	High School	College	
ALABAMA			University of Alabama, Tuscaloosa	1987–1990
ALASKA			University of Alaska, Fairbanks	1996
ARIZONA			Arizona State University, Tempe	2009
			Tuba City High School	1988
			University of Arizona, Tucson	2011
ARKANSAS			Henderson State University, Arkadelphia	1992
CALIFORNIA			California State University, Dominguez Hills	2009
			California State University, Fullerton	2000
			California Institute of Technology, Pasadena	2007
			Canada College, Redwood City	1997
			City College of San Francisco	2006
			City College of San Francisco	2011
			Contra Costa County Office of Education, Pleasant Hill	2002, 2009
			Foothill College, Los Altos Hills	1997
			Harbor-UCLA Research & Education Institute, Torrance	2003
			Laney College, Oakland	1999
			Los Angeles Biomedical Research Institute (LA Biomed), Torrance	2006
			Lutheran University, Thousand Oaks	1999
			Oxnard Community College, Oxnard	2009
			Pasadena City College	2010
			Pierce College, Los Angeles	1998
			Salk Institute for Biological Studies, La Jolla	2001, 2008
			San Francisco State University	1991
			San Jose State University	2005
			Santa Clara University, Santa Clara	2010
			University of California, Berkeley	2010
			University of California, Davis	1986
			University of California, Northridge	1993
			University of California, Riverside	2011
COLORADO			Aspen Science Center	2006
			Colorado College, Colorado Springs	1994, 2007
			United States Air Force Academy, Colorado Springs	1995
			University of Colorado, Denver	1998, 2009–2010
CONNECTICUT			Choate Rosemary Hall, Wallingford	1987
DISTRICT OF COLUMBIA			Howard University, Washington	1992, 1996, 2009–2010
FLORIDA			Armwood Senior High School, Tampa	1991
			Florida Agricultural & Mechanical University, Tallahassee	2007–2008
			Florida Agricultural & Mechanical University, Tallahassee	2011
			North Miami Beach Senior High School	1991
			University of Miami School of Medicine	2000
			University of Western Florida, Pensacola	1991
GEORGIA			Fernbank Science Center, Atlanta	1989, 2007
			Gwinnett Technical College, Lawrenceville	2011
			Morehouse College, Atlanta	1991, 1996–1997
			Spelman College, Atlanta	2010
HAWAII			Kamehameha Secondary School, Honolulu	1990
ILLINOIS			Argonne National Laboratory, Argonne	1986–1987
			iBIO Institute/Harold Washington College, Chicago	2010
			Illinois Institute of Technology, Chicago	2009
			University of Chicago	1992, 1997, 2010
INDIANA			Butler University, Indianapolis	1987
IDAHO			University of Idaho, Moscow	1994
IOWA			Drake University, Des Moines	1987
KANSAS			University of Kansas, Lawrence	1995
KENTUCKY			Murray State University, Murray	1988
			University of Kentucky, Lexington	1992

	Western Kentucky University, Bowling Green	1992
LOUISIANA	Bossier Parish Community College, Bossier City	2009
	Jefferson Parish Public Schools, Harvey	1990
	John McDonogh High School, New Orleans	1993
MAINE	Bates College, Lewiston	1995
	Foundation for Blood Research, Scarborough	2002
MARYLAND	Annapolis Senior High School	1989
	Bowie State University, Bowie	2011
	Frederick Cancer Research Center, Frederick	1995
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools, Rockville	1990–1992
	National Center for Biotechnology Information, Bethesda	2002
	<i>St. John's College, Annapolis</i>	1991
	University of Maryland, School of Medicine, Baltimore	1999
MASSACHUSETTS	Arnold Arboretum of Harvard University, Roslindale	2011
	Beverly High School	1986
	Biogen Idec, Cambridge	2002, 2010
	Boston University	1994, 1996
	CityLab, Boston University School of Medicine	1997
	Dover-Sherborn High School, Dover	1989
	Randolph High School, Randolph	1988
	The Winsor School, Boston	1987
	Whitehead Institute for Biomedical Research, Cambridge	2002
MICHIGAN	Athens High School, Troy	1989
MINNESOTA	Minneapolis Community and Technical College	2009
	University of Minnesota, St. Paul	2005
	University of Minnesota, St. Paul	2010
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990–1991
	Rust College, Holly Springs	2006–2008, 2010
MISSOURI	St. Louis Science Center	2008–2010
	Stowers Institute for Medical Research, Kansas City	2002, 2008
	Washington University, St. Louis	1989, 1997, 2011
NEVADA	University of Nevada, Reno	1992
NEW HAMPSHIRE	Great Bay Community College, Portsmouth	2009
	New Hampshire Community Technical College, Portsmouth	1999
	St. Paul's School, Concord	1986–1987
NEW JERSEY	Coriell Institute for Medical Research, Camden	2003
	Raritan Valley Community College, Somerville	2009
NEW MEXICO	Bio-Link Southwest Regional Meeting, Albuquerque	2008
NEW YORK	Albany High School	1987
	American Museum of Natural History, New York	2007
	Bronx High School of Science	1987
	Canisius College, Buffalo	2007
	Canisius College, Buffalo	2011
	Cold Spring Harbor High School	1985, 1987
	Columbia University, New York	1993
	Cornell University, Ithaca	2005
	<i>DeWitt Middle School, Ithaca</i>	1991, 1993
	DNA Learning Center <i>West</i> , Lake Success	2005
	Dolan DNA Learning Center, Cold Spring Harbor	1988–1995, 2001– 2004, 2006–2009
	Dolan DNA Learning Center, Cold Spring Harbor	1990, 1992, 1995, 2000–2011
	<i>Dolan DNA Learning Center, Cold Spring Harbor</i>	1990–1992
	<i>Fostertown School, Newburgh</i>	1991
	<i>Harlem DNA Lab</i> , East Harlem	2008–2009, 2011
	Huntington High School	1986
	Irvington High School	1986
	John Jay College of Criminal Justice, New York	2009

	<i>Junior High School 263, Brooklyn</i>	1991
	<i>Lindenhurst Junior High School</i>	1991
	Mount Sinai School of Medicine, New York	1997
	New York City Department of Education	2007
	New York Institute of Technology, New York	2006
	New York Institute of Technology, New York	2006
	<i>Orchard Park Junior High School</i>	1991
	<i>Plainview–Old Bethpage Middle School</i>	1991
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–1990
	Stuyvesant High School, New York	1998–1999
	The Rockefeller University, New York	2003
	The Rockefeller University, New York	2010
	<i>Titusville Middle School, Poughkeepsie</i>	1991, 1993
	Trudeau Institute, Saranac Lake	2001
	Union College, Schenectady	2004
	United States Military Academy, West Point	1996
	Wheatley School, Old Westbury	1985
NORTH CAROLINA	CIIT Center for Health Research, Triangle Park	2003
	North Carolina Agricultural & Technical State University, Greensboro	2006–2007, 2009–2011
	North Carolina School of Science, Durham	1987
OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	Langston University, Langston	2008
	North Westerville High School	1990
OKLAHOMA	Oklahoma City Community College	2000
	Oklahoma City Community College	2006–2007, 2010
	Oklahoma Medical Research Foundation, Oklahoma City	2001
	Oklahoma School of Science and Math, Oklahoma City	1994
	Tulsa Community College	2009
OREGON	Kaiser Permanente–Center for Health Research, Portland	2003
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy	1988
	Kimmel Cancer Center, Philadelphia	2008
RHODE ISLAND	Botanical Society of America, Providence	2010
SOUTH CAROLINA	Clemson University	2004
	Medical University of South Carolina, Charleston	1988
	University of South Carolina, Columbia	1988
TENNESSEE	NABT Professional Development Conference, Memphis	2008
TEXAS	Austin Community College–Rio Grande Campus	2000
	Austin Community College–Eastview Campus	2007–2009
	Houston Community College Northwest	2009–2010
	J.J. Pearce High School, Richardson	1990
	Langham Creek High School, Houston	1991
	University of Lone Star College, Kingwood	2011
	Midland College	2008
	Southwest Foundation for Biomedical Research, San Antonio	2002
	Taft High School, San Antonio	1991
	Texas A&M, AG Research and Extension Center, Weslaco	2007
	Trinity University, San Antonio	1994
	University of Texas, Austin	1999, 2004, 2010
	University of Texas, Brownsville	2010
UTAH	University of Utah, Salt Lake City	1993
	University of Utah, Salt Lake City	1998, 2000
	Utah Valley State College, Orem	2007
VERMONT	University of Vermont, Burlington	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	Jefferson School of Science, Alexandria	1987

	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
	Virginia Polytechnic Institute and State University, Blacksburg	2005, 2008–2009
WASHINGTON	Fred Hutchinson Cancer Research Center, Seattle	1999, 2001, 2008
	Shoreline Community College, Shoreline	2011
	University of Washington, Seattle	1993, 1998, 2010
WEST VIRGINIA	Bethany College, Bethany	1989
WISCONSIN	Blood Center of Southeastern Wisconsin, Milwaukee	2003
	Madison Area Technical College	1999, 2009, 2011
	Marquette University, Milwaukee	1986–1987
	University of Wisconsin, Madison	1988–1989
	University of Wisconsin, Madison	2004
WYOMING	University of Wyoming, Laramie	1991
PUERTO RICO	Universidad del Turabo, Gurabo, Puerto Rico	2011
	University of Puerto Rico, Mayaguez	1992
	University of Puerto Rico, Mayaguez	1992
	University of Puerto Rico, Rio Piedras	1993
	University of Puerto Rico, Rio Piedras	1994
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AUSTRALIA	Walter and Eliza Hall Institute and University of Melbourne	1996
AUSTRIA	Vienna Open Lab	2007
CANADA	Red River Community College, Winnipeg, Manitoba	1989
CHINA	Ho Yu College, Hong Kong	2009
GERMANY	Urania Science Center, Berlin	2008
ITALY	International Institute of Genetics and Biophysics, Naples	1996
	Porto Conte Research and Training Laboratories, Alghero	1993
MEXICO	ASPB Plant Biology, Merida	2008
PANAMA	University of Panama, Panama City	1994
RUSSIA	Shemyakin Institute of Bioorganic Chemistry, Moscow	1991
SINGAPORE	National Institute of Education	2001–2005
SWEDEN	Kristineberg Marine Research Station, Fiskebackskil	1995
	Uppsala University	2000
THE NETHERLANDS	International Chromosome Conference, Amsterdam	2007