Preparing students and families to thrive in the gene age

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 MacArthur 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% ± 16 vs. posttest 81% ± 14; t_{56} = 5.535, P < 0.001). Follow-up surveys showed that of the 2009 and 2010 program participants, 81% had improved
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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 constructing 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.
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.

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 devolvement 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.
Partnerships and Graduate Training

We continued our partnership with Cold Spring Harbor High School (CSHHS) to offer *Molecular and Genomic Biology*. This college-level course is scheduled during the last two class periods and is co-instructed 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 Carlson 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 co-advises 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.

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 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 (Herricks). 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.
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

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<thead>
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<tr>
<td>January 15</td>
<td>HHMI Professional Development, <em>Detecting Genetically Modified Organism</em> Workshop, Harlem DNA Lab</td>
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<tr>
<td>January 15–19</td>
<td>Plant and Animal Genome XIX Conference, Town and Country Convention Center, &quot;DNA Subway: The Fast Track to Gene Annotation,&quot; San Diego, California</td>
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<td>January 21–22</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education</em> Workshop, Florida A&amp;M University, Tallahassee, Florida</td>
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<td>January 22</td>
<td>Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York</td>
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<tr>
<td>January 29</td>
<td>Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York</td>
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<td>February 4</td>
<td>Site visit by Christine Marizzi, Max F. Perutz Laboratories, Vienna, Austria</td>
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<td>February 5</td>
<td>HHMI Professional Development, <em>DNA Structure and Isolation</em> Workshop, Harlem DNA Lab</td>
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<td>February 8</td>
<td>Site visit by Wang Lei, Zhu Yan, and Li Zhenghua, Beijing No. 166 High School, Beijing, China</td>
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<td>February 12</td>
<td>HHMI Professional Development <em>Discovering the Urban Environment</em> Workshop, New York Academy of Science, New York</td>
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<td>February 25–26</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education</em> Workshop, University of Arizona, Tucson</td>
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<td>February 26</td>
<td><em>Samurai DNA</em> DNALC</td>
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<td>March 8</td>
<td>HHMI Professional Development, <em>Variability and Inheritance</em> Workshop, Harlem DNA Lab</td>
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<tr>
<td>March 8–9</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education</em> Workshop, City College of San Francisco, California</td>
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<td>March 19</td>
<td><em>Urban Barcode Project</em> Information Session, Harlem DNA Lab</td>
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<td>March 21–24</td>
<td>Joint Genome Institute User Meeting, Walnut Creek, California</td>
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<tr>
<td>March 25</td>
<td>HHMI Professional Development, <em>DNA Analysis and Forensics</em> Workshop, Harlem DNA Lab</td>
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<tr>
<td>March 26</td>
<td>HHMI Professional Development, <em>DNA Analysis and Forensics</em> Workshop, Harlem DNA Lab, <em>Saturday DNA!</em> &quot;Recovering the Romanovs,&quot; DNALC</td>
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<td>April 2</td>
<td><em>Urban Barcode Project</em> Training Session, Harlem DNA Lab</td>
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<td>April 8</td>
<td>HHMI Professional Development, <em>PCR and Human DNA Variation, Part 1 Workshop</em>, Harlem DNA Lab</td>
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<tr>
<td>April 15–16</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education</em> Workshop, North Carolina A&amp;T State University, Greensboro</td>
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<td>April 16</td>
<td><em>Saturday DNA!</em> &quot;Milky Menace,” DNALC</td>
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<td>April 27</td>
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<td>April 30</td>
<td><em>Urban Barcode Project</em> Training Session, Harlem DNA Lab</td>
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<td>April 30–May 3</td>
<td>NSF ATE <em>Genomic Approaches in Biosciences</em>, Advisory Board Meeting, CSHL</td>
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<td>May 5</td>
<td><em>Great Moments in DNA Science</em> Honors Seminar: “Sowing the Next-Generation ‘Green Revolution’: Genetics and Genomics of Maize Development,” Andrea Eveland, CSHL, DNALC</td>
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<tr>
<td>May 6</td>
<td>HHMI Professional Development, <em>PCR and Human DNA Variation, Part 2 Workshop</em>, Harlem DNA Lab</td>
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<tr>
<td>May 6–7</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education</em> Workshop, Bowie State University, Maryland</td>
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<td>May 7</td>
<td>HHMI Professional Development, <em>PCR and Human DNA Variation, Part 2 Workshop</em>, Harlem DNA Lab</td>
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<td>May 8–12</td>
<td>National Institutes of Health Science Education Partnership Award Principal Investigators Conference, &quot;Nationwide Dissemination of Inside Cancer,&quot; Seattle, Washington</td>
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<td>May 10</td>
<td>Site visit by Leo Brizuela and Jim Lynch, Agilent, Santa Clara, California</td>
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<td>May 12</td>
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<td>May 14</td>
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<td>May 18</td>
<td>Science Coordinators Network Meeting, Dowling College, Oakdale, New York</td>
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<td>May 21</td>
<td><em>Saturday DNA</em> &quot;Personalized Medicine,&quot; DNALC</td>
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<td>June 4</td>
<td><em>Urban Barcode Project</em> Training Session, <em>Harlem DNA Lab</em></td>
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<td>June 4–5</td>
<td>World Science Festival, &quot;<em>Harlem DNA Lab,</em>&quot; and &quot;<em>DNA Subway,</em>&quot; New York</td>
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<td>June 6–10</td>
<td>Teacher Professional Development Workshop, The Chapin School, New York</td>
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<td>June 7</td>
<td>18th Annual Golf Outing, Piping Rock Club, Locust Valley, New York</td>
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<td>June 10</td>
<td>NSF Shoot Apical Meristem Meeting, CSHL</td>
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<td>June 11</td>
<td><em>Urban Barcode Project</em> Training Session, Genspace, Brooklyn, New York</td>
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<td>June 13–17</td>
<td><em>DNA Science Workshop</em>, Trinity School, New York</td>
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<td>June 16</td>
<td>Site visit by Gregory Crawford, University of Notre Dame, Indiana</td>
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<td>June 18</td>
<td><em>Saturday DNA</em> &quot;Express Yourself!* DNALC</td>
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<td>June 22–26</td>
<td>18th International <em>C. elegans</em> Meeting, University of California, Los Angeles</td>
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<td><em>DNA Science Workshop</em>, DNALC</td>
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<td><em>Fun with DNA Workshop</em>, DNALC West</td>
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<td><em>World of Enzymes Workshop</em>, DNALC</td>
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<td>July 5–8</td>
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<td><em>Green Genes Workshop</em>, DNALC</td>
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<td><em>Plant Genomics Workshop</em>, DNALC</td>
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<td><em>World of Enzymes Workshop</em>, DNALC West</td>
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<td>July 5</td>
<td>HHMI Professional Development, <em>DNA Structure and Isolation Workshop</em>, <em>Harlem DNA Lab</em></td>
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<td>July 6</td>
<td>HHMI Professional Development, <em>Variability and Inheritance Workshop</em>, <em>Harlem DNA Lab</em></td>
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<td>July 7</td>
<td>HHMI Professional Development, <em>DNA Transformation and Protein Isolation Workshop</em>, <em>Harlem DNA Lab</em></td>
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<td>July 7–8</td>
<td>NSF <em>iPlant Collaborative</em> Professional Development, <em>Genomics in Education Workshop</em>, Washington University, St. Louis, Missouri</td>
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<td>July 8</td>
<td>HHMI Professional Development, <em>DNA Analysis and Forensics Workshop</em>, <em>Harlem DNA Lab</em></td>
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<tr>
<td>July 9–10</td>
<td>Botanical Society of America, “<em>DNA Subway,</em>” and “<em>DNA Barcoding,</em>” St. Louis, Missouri</td>
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<td>July 11–15</td>
<td><em>DNA Science Workshop</em>, DNALC West</td>
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<td><em>Human Genomics Workshop</em>, Central Idip</td>
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<td><em>Human Genomics Workshop</em>, DNALC</td>
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<td></td>
<td><em>World of Enzymes Workshop</em>, DNALC West</td>
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<td>July 11</td>
<td>HHMI Professional Development, <em>DNA Transformation and Protein Isolation Workshop</em>, <em>Harlem DNA Lab</em></td>
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<td>July 12</td>
<td>HHMI Professional Development, <em>DNA Analysis and Forensics Workshop</em>, <em>Harlem DNA Lab</em></td>
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<tr>
<td>July 13</td>
<td>HHMI Professional Development, <em>PCR and Human DNA Variation, Part 1 Workshop</em>, <em>Harlem DNA Lab</em></td>
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<tr>
<td>July 14</td>
<td>HHMI Professional Development, <em>PCR and Human DNA Variation, Part 2 Workshop</em>, <em>Harlem DNA Lab</em></td>
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<tr>
<td>July 15</td>
<td>HHMI Professional Development and <em>Urban Barcoding Project</em> Training Session, “<em>DNA Barcoding,</em>” <em>Harlem DNA Lab</em></td>
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<td>July 18–22</td>
<td><em>Fun with DNA Workshop</em>, DNALC</td>
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<td><em>Green Genes Workshop</em>, DNALC</td>
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<td><em>Green Genes Workshop</em>, DNALC West</td>
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<td><em>Silencing Genomes Workshop</em>, DNALC</td>
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<td>July 18–29</td>
<td>HHMI Professional Development, Leadership Symposium, <em>Harlem DNA Lab</em></td>
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<td><em>Forensic Detectives Workshop</em>, DNALC</td>
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Executive Director’s Report

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<tr>
<td>July 25–Aug. 12</td>
<td>Genetic Horizons Workshop, DNALC West</td>
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<td></td>
<td>Introduction to Genetics and Biochemistry, DNA Science, and Genome Science Workshops, Beijing No. 166 High School, DNALC</td>
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<td>July 29</td>
<td>HHMI Professional Development and Urban Barcode Project Training Session, “DNA Barcoding,” Harlem DNA Lab</td>
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<tr>
<td>August 1–5</td>
<td>Fun with DNA Workshop, DNALC West</td>
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<tr>
<td>August 1</td>
<td>HHMI Professional Development, DNA Structure and Isolation Workshop, Harlem DNA Lab</td>
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<tr>
<td>August 2</td>
<td>HHMI Professional Development, Variability and Inheritance Workshop, Harlem DNA Lab</td>
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<td>August 3</td>
<td>HHMI Professional Development, DNA Transformation and Protein Isolation Workshop, Harlem DNA Lab</td>
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<td>August 4</td>
<td>HHMI Professional Development, DNA Analysis and Forensics Workshop, Harlem DNA Lab</td>
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<td>August 5</td>
<td>HHMI Professional Development, PCR and Human DNA Variation, Part 1 Workshop, Harlem DNA Lab</td>
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<td>August 8</td>
<td>HHMI Professional Development, DNA Transformation and Protein Isolation Workshop, Harlem DNA Lab</td>
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<td>August 8–12</td>
<td>NSF ATE Professional Development, Genomic Approaches in Biosciences Workshop, Universidad del Turabo, Gurabo, Puerto Rico</td>
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<tr>
<td>August 15–19</td>
<td>NSF ATE Professional Development, Genomic Approaches in Biosciences Workshop, Madison Area Technical College, Wisconsin</td>
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<td>August 16</td>
<td>Urban Barcode Project Training Session, Harlem DNA Lab</td>
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<td>August 19</td>
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<td>August 22–26</td>
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<td>August 23</td>
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<td>August 26</td>
<td>Site visit by Pat Hayot, Michael Maloy, and Jill Hirsch, The Chapin School, New York</td>
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<td>Aug. 29–Sept. 2</td>
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<tr>
<td>September 1</td>
<td>Urban Barcode Project Information Session, New York Botanical Garden, Bronx, New York</td>
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<td>September 7</td>
<td>Urban Barcode Project Information Session, Richard Gilder Graduate School, American Museum of Natural History, New York</td>
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<td>September 16</td>
<td>Urban Barcode Project Information Session, Trinity High School, New York</td>
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<td>September 17</td>
<td>Urban Barcode Project Promotion at Maker Faire, New York Hall of Science, Queens, New York</td>
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<td>September 19</td>
<td>Graduate Student Training for STEM Mentoring Program, New York Academy of Science, New York</td>
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<td>September 21</td>
<td>Urban Barcode Project Training Session, Harlem DNA Lab</td>
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<td>September 23</td>
<td>Urban Barcode Project Information Session, The Gateway Institute, New York</td>
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<td>September 26</td>
<td>Urban Barcode Project Information Session, Brooklyn Bridge Park, Brooklyn New York</td>
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<tr>
<td>September 28</td>
<td>Urban Barcode Project Information Session, American Museum of Natural History, New York</td>
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<tr>
<td>September 29</td>
<td>Urban Barcode Project Training Session, Harlem DNA Lab</td>
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*DNALC West*
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<td>October 3</td>
<td>Site visit by James Bono, Buck Koonce, and Camille Bibeau, Lawrence Livermore National Laboratory, Livermore, California</td>
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<td>October 5</td>
<td>Urban Barcode Project Information Session, The River Project, New York University, New York</td>
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<td>October 7</td>
<td>Site visit by Kim Kerns and Katya Lanfant, Cablevision, New York</td>
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<td>October 8</td>
<td>Urban Barcode Project Training Session, Harlem DNA Lab</td>
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<tr>
<td>October 11–12</td>
<td>NSF iPlant Collaborative Professional Development, Genomics in Education Workshop, University of California, Riverside</td>
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<td>October 12</td>
<td>Saturday DNA! “Superbugs Uncovered,” DNALC</td>
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<td>October 14</td>
<td>Urban Barcode Project Information Session, The Urban Assembly, New York</td>
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<td>October 22</td>
<td>HHMI Professional Development, DNA Transformation and Protein Isolation Workshop, Harlem DNA Lab</td>
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<td>October 24</td>
<td>Site visit by Ania Wieczorek, University of Hawaii, Manoa, Hawaii</td>
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<td>October 25</td>
<td>Site visit by Mathias Schmitt, ARTF, Strasbourg Cedex, France</td>
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<tr>
<td>October 27</td>
<td>Urban Barcode Project Information Session, Brooklyn Technical High School, Brooklyn, New York</td>
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<tr>
<td>October 28–29</td>
<td>NSF iPlant Collaborative Professional Development, Genomics in Education Workshop, Arnold Arboretum of Harvard University, Roslindale, Massachusetts</td>
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<td>November 1</td>
<td>Urban Barcode Project Information Session, Department of Education, New York</td>
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<td>November 5</td>
<td>Urban Barcode Project Training Session, Genspace, Brooklyn, New York</td>
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<tr>
<td>November 8</td>
<td>HHMI Professional Development, DNA Structure and Isolation Workshop, Harlem DNA Lab</td>
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<td>November 10</td>
<td>Criminal Courts Bar Association of Nassau County, DNA Analysis and Forensics Workshop, Reception, and “DNA—Nothing to Fear,” Eric Carita, Forensic DNA Consultant, DNALC</td>
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<tr>
<td>November 11</td>
<td>Urban Barcode Project Training Session, Harlem DNA Lab</td>
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<tr>
<td>November 11–12</td>
<td>NSF iPlant Collaborative Professional Development, Genomics in Education Workshop, University of Lone Star College, Kingwood, Texas</td>
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<tr>
<td>November 14</td>
<td>Urban Barcode Project Information Session, Benjamin C. Cardozo High School, New York</td>
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<td>November 15–16</td>
<td>NSF iPlant Collaborative Professional Development, Tools and Services Workshop, National Evolutionary Synthesis Center, Durham, North Carolina</td>
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<td>National Human Genome Research Institute (NHGRI) Genomic Literacy Workshop, “Limited Effects and Genome Education in the Digital Age,” Rockville, Maryland</td>
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<td>HHMI Professional Development, DNA Analysis and Forensics Workshop, Harlem DNA Lab</td>
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## Sites of Major Faculty Workshops 1985–2011

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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
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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
St. John’s College, Annapolis 1991
University of Maryland, School of Medicine, Baltimore 1999
MASSACHUSETTS
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Beverly High School 1986
Biogen Idec, Cambridge 2002, 2010
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MINNESOTA
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Fostertown School, Newburgh 1991
Harlem DNA Lab, East Harlem 2008–2009, 2011
Huntington High School 1986
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John Jay College of Criminal Justice, New York 2009
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