



Cold Spring Harbor Laboratory  
DNA LEARNING CENTER



2019 ANNUAL REPORT

The DNA Learning Center is an operating unit of Cold Spring Harbor Laboratory, extending its traditional research and postgraduate education mission to the college, pre-college, and public levels. Founded in 1988, the DNALC is the world's first science center devoted entirely to genetics education.

The mission of the DNA Learning Center is to prepare students and families to thrive in the gene age. We envision a day when all elementary students are exposed to principles of genetics and disease risk; when all high school students have the opportunity to do hands-on experiments with DNA; and when all families have access to genetic information they need to make informed health care choices.

Front cover: Students in the Science Technology and Research Scholars (STARS) program prep a gel. The STARS program is a two-week research experience designed to support the next generation of minority scientists, doctors, and health professionals.

## Executive Director's Report

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### Coming Home to Brooklyn

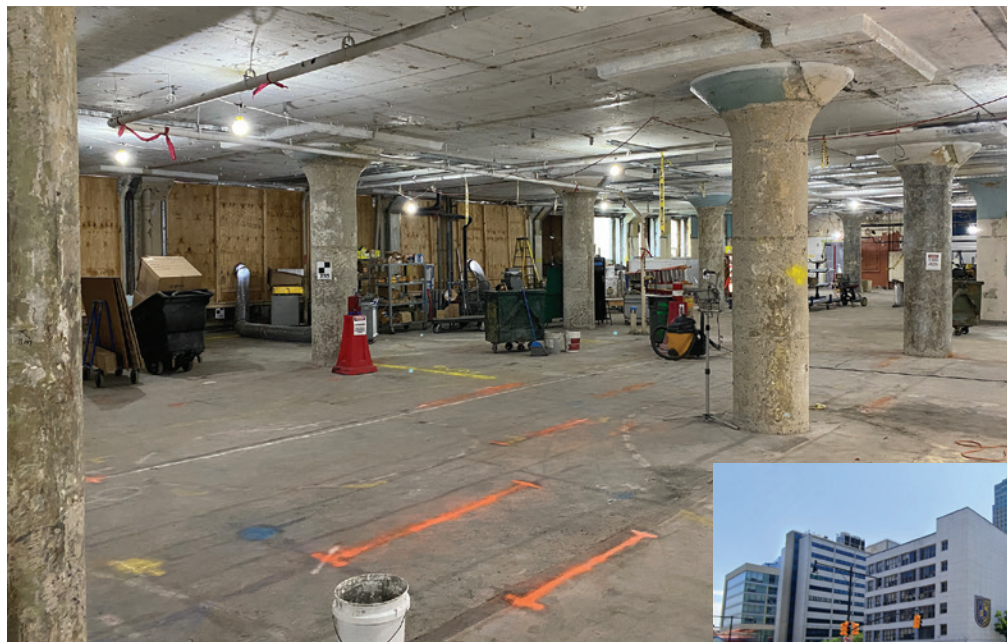
On October 1<sup>st</sup>, we signed a 30-year, no-cost lease with the City University of New York (CUNY) for an 18,000 square-foot space on the campus of the New York City (NYC) College of Technology (City Tech) in downtown Brooklyn. This was preceded by three years of legal wrangling with city and state authorities that control the property and the complicated public bonds through which it is financed. In this effort we had the unflagging support of City Tech President Russ Hotzler, who used his former experience as vice chancellor and president of several CUNY colleges to guide us through the bureaucratic process. The new facility is designed by Centerbrook Architects and Planners, who have done all architectural work for CSHL over the past 50 years—including the expansion of the DNALC in 2001. With renovations beginning in spring 2020, we expect to bring the facility into operation in time for summer camps in 2021.

Starting a new DNALC location at the “Gateway to Brooklyn” also recalls CSHL’s little-known historical relationship to Brooklyn. The Biological Laboratory at Cold Spring Harbor was, in fact, founded in 1890 as the first operating unit of the newly incorporated Brooklyn Institute of Arts and Sciences—which later grew to include the Brooklyn Museum, Botanical Garden, Children’s Museum, and Conservatory of Music. So, in joining its sister institutions along the axis of Flatbush Avenue, the DNALC will be coming home to Brooklyn.

Finding the City Tech location was the culmination of a 13-year search for a space in which to extend the DNALC’s model for bioscience enrichment to the students of metropolitan New York. Our vision is to provide a place where all NYC students have the same science learning and research opportunities that have been available to elite Long Island students for several decades. The Brooklyn center will build upon our success with *Harlem DNA Lab*, which has provided lab experiences for 33,000 students since its opening in 2008. The Harlem facility demonstrated that we can readily serve a natural constituency of underrepresented minority (URM) students, who compose about two thirds of public school students in NYC. We tested the feasibility of the Brooklyn location when, in the spring, we opened a temporary lab in the same building on the City Tech campus. This filled quickly, with 1,287 students doing labs in 2019.



The City Tech temporary lab in the midst of reorganization in preparation for field trips in the fall.



Above: Partial view of the City Tech space.  
Right: Approaching the City Tech building from the Brooklyn Bridge.

The City Tech property fulfills CSHL's key requirements of educational zoning, high visibility, and ready access. DNALC branding on the building façade will be immediately visible to all traffic coming off the Brooklyn Bridge. Downtown Brooklyn is one of the most accessible areas of New York City, with eight subway lines located within several blocks of City Tech. There will be easy bus drop off on both Tillary and Adams Streets. A dedicated entrance on Tillary Street will provide direct access to the second floor.

The new facility will occupy the entire second floorplate of City Tech's Pearl Street Building. With six teaching labs and two bioinformatics labs, it will be twice the size of our flagship center in Cold Spring Harbor. The City Tech facility is also more than double the size of the 7,000 square-foot rental space we had originally conceived for NYC. So, scope of the capital project was further magnified by a "gut" renovation of the space, asbestos abatement, entire HVAC upgrade, and replacement of windows and exterior cladding of the entire second floor.

The enlarged space will have increased operating costs—especially staffing. Early on, we also made the commitment to provide free tuition to at least half of students attending academic year field trips and to initiate an ambitious research program for CUNY students. These activities will require additional endowment support. Taking all this into account, we have increased our funding goal from \$25 million to \$30 million—including about \$18 million for construction and \$12 million for endowment.

At City Tech, we will continue our proven program of academic-year field trips and summer camps for precollege students. The hands-on lab work will be complemented by minds-on bioinformatics exercises, which will engage students with the coding, computational, and data science skills critical for STEM success.

The City Tech location will also provide a proving ground for our work in undergraduate education. Here the emphasis is on course-based undergraduate research experiences (CUREs). As opposed to the traditional undergraduate research model, which places a small number of

students with individual faculty mentors, CUREs expand research opportunities to all interested students in the context of for-credit courses. When rigorously implemented, especially in the freshman year, CUREs increase retention in STEM majors and on-time graduation by about 20%. Most of the DNALC's federal funding over the last two decades has been devoted to developing experiment and computer infrastructure to support CUREs. Two teaching labs in the Brooklyn facility will be used exclusively for research by CUNY students, and we hope to quickly establish one of the country's largest CUREs—serving up to 900 students per year.

The City Tech facility will provide an ideal setting for our CURE work and also as the designated Genomics Hub of InnovATEBIO, the National Biotechnology Education Center. As explained later in this report, this National Science Foundation (NSF) project explicitly supports workforce development and bioscience career pathways in two-year institutions. City Tech is unique among CUNY institutions, in having both two-year and four-year programs on the same campus. City Tech has 17,300 students—of whom 62% of are Black and Hispanic and 67% are the first in their family to attend college—and is officially designated as a Hispanic Serving Institution (HSI). CUNY is the largest urban university system in the U.S. and one of the largest producers of African-American doctoral degrees in the natural sciences and engineering.

The downtown Brooklyn location has strong foot traffic, so we intend to develop a substantial business of “drop-in” visitors on the weekends. We want to make the DNALC a prominent travel destination for people interested in learning what DNA can tell them about their health and their place in the human family. The stories told in the 2,700 square foot exhibit will integrate tightly tailored student experiments and family activities. Our most popular human experiment uses a person's own DNA type to predict their bitter-tasting ability, a direct analog of pharmacogenetics approach of using a DNA signature to predict a person's response to a particular drug or chemotherapy.

We popularized the first “personal DNA” experiment 20 years ago. So we envision a day when every DNALC visitor has the opportunity to look at their DNA and compare it to classmates and world populations to show the shared ancestry of all people. This experiment would articulate with a large-scale interactive map that uses personal DNA data to illustrate the prehistoric migration of humans out of Africa that peopled the Old and New Worlds. We will also show the genetic signatures of historic diasporas of ethnic and religious groups, and the spread of innovations—farming, horse culture, and dairying. All of this would be complemented with replicas of ancient ancestors, including those developed by the DNALC—Ötzi the Iceman, developed from CT-scan data, and the first articulated Neanderthal skeleton. Visitors could extend their DNA journey with a visit to nearby Ellis Island National Monument, which greeted the ancestors of approximately 40% of Americans alive today. The Tenement Museum and Museum of the City of New York give further depth to the story of how New York became the U.S. melting pot and provide opportunities for detailed exploration of individual ancestry.

## Biotechnology in American High Schools

As part of an early grant from the NSF's Advanced Technological Education (ATE) program, the DNALC conducted a nationwide survey of 4,100 high school biology teachers. This sample took a snapshot of biotechnology/molecular genetics instruction in American high schools in 1998. The survey was designed to compare lab instruction and student exposures to six major techniques of biotechnology/molecular genetics that were measured in the original survey: bacterial transformation, DNA restriction analysis, DNA recombination, plasmid isolation, polymerase chain reaction (PCR), and DNA sequencing. With renewed funding from NSF, we repeated this study in 2018 receiving 2,100 responses from high school biology teachers across the country. Following are the highlights of changes we found in biotechnology instruction over the past two decades.

**The number of students exposed to six biotech labs has increased, and teaching these labs has become more mainstream. However, fewer faculty are involved in biotech teaching, and the pace of integrating new labs has slowed.**

- The number of faculty offering biotech labs in AP Biology has decreased (62% to 54%), while those offering biotech labs in general biology have increased by a similar margin (21% to 28%).
- Although more faculty offer labs on PCR and DNA sequencing today, it is at half the rate that teachers offered the then-novel methods of transformation and restriction analysis in 1998.

	1998 (n = 4,100)		2018 (n = 2,100)	
	% Teaching	Reported Annual Student Exposures	% Teaching	Reported Annual Student Exposures
<b>Transformation</b>	51%	80,384	45%	106,453
<b>Restriction analysis</b>	60%	118,490	43%	135,240
<b>DNA recombination</b>	32%	47,666	25%	65,785
<b>Plasmid isolation</b>	17%	24,312	15%	31,044
<b>PCR</b>	12%	21,576	26%	28,498
<b>DNA sequencing</b>	16%	29,398	20%	39,334
<b>Total Exposures</b>		321,826		406,354

**Biotech funding and electives have doubled since 1998. However, few schools with biotech electives were aligned with the school-to-work movement as advocated by the NSF ATE program, and advanced teaching is concentrated in wealthier districts.**

- Adjusted for inflation, per-teacher funding for biotech has increased from \$8,236 to \$16,651.
- Schools offering lab-based biotech electives increased from 16% to 35%.
- Although 35% of faculty at schools with biotech electives used curriculum materials provided by industry, only 11% used ATE materials and only 22% of these schools had articulation agreements with colleges.
- 68% of schools with biotech electives in 2018 were located in zip codes above the U.S. median household income.

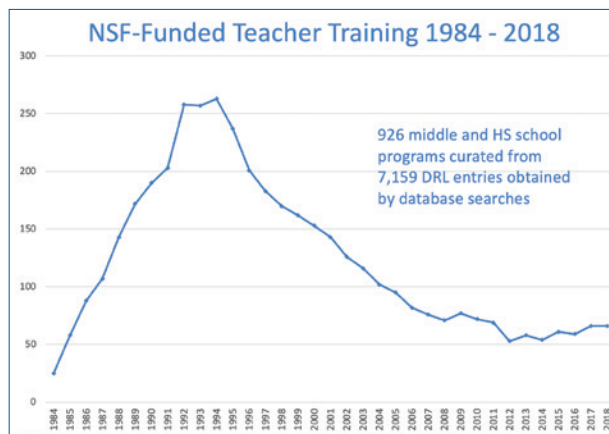
**Although 2018 faculty are more academically prepared, they are less involved with professional societies and extracurricular activities.**

- 80% of 2018 teachers had graduate degrees compared to 74% in 1998.
- Significantly fewer 2018 teachers belonged to major professional societies, including NABT, NSTA, and state science teachers’ associations.
- Significantly fewer 2018 teachers participated in all types of extracurricular activities with their students.
- Significantly more 2018 teachers said they did no out-of-class science activities at all.

	1998	2018
After-school student research	26%	18%
Science fairs/competitions	36%	26%
Science field trips	53%	42%
Joint activities with scientists from local universities/institutes	24%	16%
None of the above	27%	41%

Consistently over the last 20 years, teachers said they valued summer workshops of 5+ days and workshops at professional meetings as the important contributors to innovation in the classroom. However, whereas 65% of 1998 teachers had attended one or more professional meetings in the past year, 60% of 2018 teachers had attended none. Furthermore, 39% of 2018 faculty thought there were fewer opportunities for training at workshops and summer institutes than in the past, compared to 27% who thought there were more. This suggested a disturbing trend of today's biology teachers having less access to the very types of training that can keep them involved and up-to date. This jived with our own observations and those of others who have done grant-funded training over the last several decades.

Traditionally, the NSF has been the major provider of focused, high-quality training for precollege biology teachers. So, we examined 7,454 entries in database of education grants made by the NSF, going back to 1982 when the database appears to have been started. Of these, we determined that 948 offered training opportunities of interest to middle and high school biology educators, and we plotted a graph of the years in which they were active. NSF teacher training opportunities peaked in 1994, when 263 training programs were operational. From that point, NSF training dropped precipitously, falling to 170 in 1998 and reaching its nadir in 2012, when there were 53 programs. The number of new programs had recovered somewhat, to 66 by 2018. Our database analysis confirmed the subjective feeling among 2018 teachers that there were fewer training opportunities available to them. In fact, 2018 had only 38% of the NSF training opportunities as did the 1998 cohort and only 25% as many as teachers in 1994. This amounts to an abdication of a core principle of the NSF Authorization Act of 1973, which made NSF explicitly responsible for "science education at all levels." It is reason for alarm, at a time when biology is progressing so quickly and pandemic isolation is rendering lab instruction nearly impossible. It is a perfect storm to rip apart the hands-on biology instruction that is the bastion of American science learning.



### NSF CyVerse Study of Bioinformatics Education

CyVerse is an NSF-funded cyberinfrastructure for life sciences. The project merges high performance computing, data storage, and people to solve complex biological problems. DNALC training offered through CyVerse focuses on the "people" component of cyberinfrastructure, equipping educators with bioinformatics and data science teaching skills. As part of the Network for Integrating Bioinformatics into Life Science Education (NIBLSE), we led research on barriers educators face in teaching bioinformatics. In the largest nationwide study on the topic to date\*, more than 1,200 undergraduate biology faculty revealed that they struggle with teaching bioinformatics primarily due to their own lack of training. Underrepresented minority (URM) faculty and faculty at two-year and minority-serving institutions reported increased barriers compared to their peers. Surprisingly, although recent graduates had better training in bioinformatics, they were less likely to teach this topic than senior faculty. Taken together, the findings highlight the need for more professional

\*Williams JJ, Drew JC, Galindo-Gonzalez S, Robic S, Dinsdale E, Morgan WR, et al. (2019) Barriers to integration of bioinformatics into undergraduate life sciences education: A national study of US life sciences faculty uncover significant barriers to integrating bioinformatics into undergraduate instruction. PLoS ONE 14(11): e0224288. <https://doi.org/10.1371/journal.pone.0224288>

development and better support for biology faculty as they teach computational topics. Our study also pointed up the need to level the intellectual playing field for URMs. In response to our own studies, we have refocused CyVerse training efforts on longer-duration workshops, including a new, week-long Foundational Open Science Skills (FOSS) course that helps faculty integrate bioinformatics and computational tools into their classroom teaching. We are also redoubling our effort to include URM faculty and to site training at URM-serving institutions.

## DNA Barcoding and Metabarcoding

The DNALC continued its concerted efforts to enable high school and college students to conduct authentic biodiversity research using DNA barcoding. Three programs support high school students. *Barcode Long Island (BLI)*, funded by the National Institutes of Health (NIH), involves students in “campaigns” to compare biodiversity across Long Island. The *Urban Barcode Project (UBP)*, funded by the Thompson Family Foundation, and *Urban Barcode Research Program (UBRP)*, funded by matching grants from the Pinkerton Foundation and Simons Science Sandbox, involve students in independent research of biodiversity in NYC. Science teachers are mentors for *BLI* and *UBP* students, while scientists from NYC institutions mentor *UBRP* students. A new collaboration with Hudson River Park, funded by the Lounsbery Foundation, piloted student and citizen science involvement in metabarcoding of fish. Major funding from the NSF Improving Undergraduate STEM Education (IUSE) and ATE programs support the development and dissemination of CUREs for undergraduate students.

Over the year, we improved the biochemical and online resources that support all of these programs, and are making barcoding and metabarcoding accessible to students worldwide. A new, rapid DNA isolation kit makes DNA barcoding more achievable in short classes. A similar fast procedure for microbial and vertebrate metabarcoding also shows promise. After several rounds of testing, we redesigned our sample indexing strategy for metabarcoding—improving sequence quality and taxonomic resolving power, while maintaining the low costs we achieved in previous years. We also developed indexed primers to support invertebrate metabarcoding, expanding the repertoire of research questions we can support.

Improvements to the *DNA Barcoding 101* website (<https://www.dnabarcoding101.org>) included support materials for the new isolation method, new PCR primer information, updated DNA staining and sequencing instructions, a table of protocol choices, and guides for taxonomic identification and sample documentation. The Sample Database evolved as a simple means to enter, store, and access all information related to each student sample and barcode sequence. The website now allows users to create independent programs, allowing faculty and independent groups to manage their own DNA barcoding projects.

*DNA Subway*, the bioinformatics gateway developed by the DNALC as part of CyVerse, supports our biodiversity programs and is a popular tool for educators at all levels. In 2019, *DNA Subway* had 36,322 registered users, 63,410 visits (~4% decrease from 2018), and 1.22 million page views (~3% decrease from 2017). Students created 43,492 projects (~10% increase from 2018) across the five *Subway* lines. The Blue Line supports DNA barcoding sequence analysis, while the Purple Line is a custom and approachable interface to the metabarcoding analysis package QIIME2. This year, the Purple Line was updated to improve the speed and quality of analyses, and support for invertebrate sequence analysis was added. Crucially, we solved an analysis bottleneck that thwarted new users—we created a self-contained “wizard” that seamlessly manages and creates metadata files. Design updates gave the Purple Line a cleaner look, mirroring changes to the rest of the site.

“Upstream” of *DNA Subway*, a new laboratory information management system (LIMS) allows faculty to assign indexes to different groups and manage next generation sequencing (NGS) libraries. Anticipating a nationwide sequencing service for student metabarcoding projects,

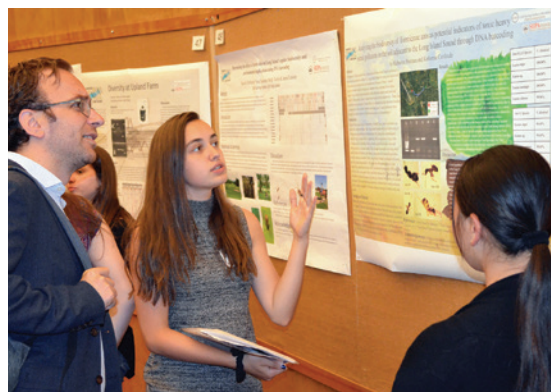


this tool can manage hundreds of samples submitted by dozens of users—and separate (deconvolute) the millions of sequence reads generated in a single NGS run.

### *High School DNA Barcoding Research Programs*

The 2019 *BLI* program included 208 students working in 79 teams and representing 25 high schools from Suffolk, Nassau, and Queens Counties. Twelve percent of participants were African American, Latino, or Native American. During the year, 73 students attended seven open lab sessions held at the Dolan DNALC, DNALC West, Stony Brook University (SBU), or Brookhaven National Laboratory (BNL), while 114 students used borrowed equipment kits. Nine teams (22 students) used high-throughput sequencing to perform metabarcoding to study marine fish, microbiomes from water, or invertebrates. Over 800 samples were processed, resulting in over 1,200 sequencing reads and 1.2 million NGS reads. We published 239 sequences in GenBank, including two new barcode sequences and 40 with sequence polymorphisms.

Sixty-eight DNA barcoding and metabarcoding projects were presented at the annual *BLI* research symposium on June 4<sup>th</sup> at CSHL. These included biodiversity studies of plants, invertebrates, fungi, algae, and lichens; microbiome studies of water, excrement, and invertebrates; and eDNA studies of fish. Dr. Semir Beyaz, CSHL Fellow and Donaldson Translational Fellow at CSHL, gave the keynote address on the interplay between diet and microbiome in cancer risk. *BLI* students received awards at numerous competitions, including the Long Island Science and Engineering Fair (LISEF) and NYC Science and Engineering Fair (NYCSEF). One group received the *Brooklyn Friends of Clearwater Award* for increasing awareness of the environment. Three teams from William Floyd High School were invited by their county legislator to present their research on effects of heavy metals on aquatic biodiversity.



The 2019 *UBP* and *UBRP* programs had 161 students working in 61 teams and representing 23 NYC high schools. *UBP* and *UBRP* students made ample use of DNALC resources: 62 students attended open lab sessions at *Harlem DNA Lab* or DNALC at City Tech, while 49 students borrowed equipment. Teams collected and processed over 1,100 samples for DNA sequencing, resulting in over 1,150 single sequences and 6.2 million NGS reads. The annual research symposium on May 30<sup>th</sup> at the New York Academy of Medicine showcased 61 projects and included a keynote speech by Dr. Claudia Wultsch of Hunter College and AMNH on the microbiomes of wild carnivores. One *UBRP* team was recognized with an outstanding poster award at the event, for a project that examined the microbiomes from the noses of e-cigarette users and non-users. The winner for *UBP* showed, that earthworm diversity is higher in private—compared to public—locations in Greenpoint, Brooklyn. One *UBP* team submitted a manuscript to the *Journal of Emerging Investigators* on using DNA barcoding to identify plant species and create a phenology trail in Central Park.

Left: Dr. Semir Beyaz presents the keynote address to *BLI* Symposium attendees and at right, talks to *BLI* participants at their poster in Bush Auditorium.



Above: Dr. Claudia Wultsch addresses *UBP* and *UBRP* student researchers who shared project results at a poster session.

This year, 118 students across all three barcoding programs (*BLI*, *UBP*, and *UBRP*) completed surveys as a part of our ongoing effort to monitor the impact of participation in science research. Participants were asked about their experiences in the programs, how much they had learned, and how they felt about science. The students were overwhelmingly proud of the research they had done (86.4%) and felt that problem-solving approaches learned during their research would be helpful in future science courses (80.9%) and careers (77.3%). Nearly three-quarters (71.3%) said they were more interested in continuing science study and, specifically, biology (74.1%). Overall, our results suggest that DNA barcoding demystifies the process of science research and encourages students to continue on STEM pathways.

#### *Studying Biodiversity in the Hudson River*

A new grant from the Richard Lounsbery Foundation supported a collaboration with the Hudson River Park (HRPK) to systematically sample water from the Hudson River. Using eDNA to identify the creatures living in the water provides a window into the life of this wild space adjacent to the nation's busiest metropolis. Beginning in January, HRPK staff and high school students collected over 200 water samples. HRPK staff were trained in eDNA processing and supported as students participating in INCLUDES, an intensive summer research program, extracted and amplified DNA for sequencing. Over 250 citizen scientists participating in HRPK summer programs collected and filtered additional water samples. Meanwhile, we led 500 visitors as they isolated DNA from organisms collected in the park during HRPK's 6<sup>th</sup> annual Submerge Marine Science Festival.

Initial results were promising, with many of the fish expected in the river appearing in the eDNA results. Highlights included identifying dolphin, endangered sturgeon, and shiner DNA. A valuable, but less exciting finding is that Hudson River vertebrate DNA is dominated by human and human-associated DNA—from our pets and food. This made it harder to find the fish DNA we were looking for.

A separate small collaboration with the Billion Oyster Project (BOP) aims to help teachers work with their students to collect and identify organisms that populate oyster cages. A Billion Oyster Project teacher joined *Urban Barcode Project* training during the summer to learn how to lead teams in preparation for work at BOP sites. Conversely, we presented DNA barcoding at the BOP Annual Science Fair, letting participants know about this new opportunity.

#### *Barcoding in Undergraduate Classes*

We continued to develop, disseminate, and assess DNA barcoding and metabarcoding as “formatted” solutions for CUREs through our \$2 million IUSE collaboration with James Madison

University (JMU), CUNY City Tech, Bowie State University (BSU), and Austin Community College (ACC). JMU has adapted the DNALC's barcoding curriculum to support a model CURE. Remarkably, this CURE reaches over 1,700 students per year. Pushing DNA barcoding into introductory classes with many underrepresented minorities, our collaborators at City Tech and BSU implemented DNA barcoding with 24 and 22 freshman students, respectively.

During the summer, JMU hosted a 5-day "DNA Barcoding for CUREs" workshop. Twenty-two undergraduate educators (18% underrepresented minority; 77% female, 23% male) representing seven two-year public, six four-year public, and five four-year private undergraduate institutions participated in the workshop designed to prepare them to successfully implement DNA barcoding CUREs. Participants learned by doing, carrying out a biodiversity study of JMU forest habitat; presentations by collaborators on the science and CURE implementations highlighted potential challenges and solutions. In a remarkably fast turn-around, nine workshop participants implemented DNA barcoding CUREs during the fall semester—reaching 242 students, including 24% underrepresented minorities. These students reported similar or better learning and attitudinal effects as students taught by project co-PIs, suggesting that the week-long training format is sufficient to launch an effective DNA barcoding CURE.



NSF IUSE DNA Barcoding Workshop participants sample campus biodiversity at JMU (left) and explore costs, benefits, and barriers of barcoding CUREs (right).

In preparation for training in 2020, the DNALC's metabarcoding pipeline was adapted and integrated into an upper-level genomics course at JMU. In this course, 14 junior and senior undergraduates and two graduate students showed that male and female snakes of the same species have different microbiomes. While developing course materials, a JMU student co-authored a manuscript outlining an introduction to command line analysis of NGS data, which is currently in review with the peer reviewed journal *CourseSource*. BSU also piloted metabarcoding with 30 students in an upper level molecular biology class, comparing the microbial diversity in different aquatic environments on campus.

### New National Center for Biotechnology Education

In October, the DNALC became a lead institution in the InnovATEBIO National Biotechnology Education Center. The center is funded through NSF ATE, which seeks to keep America's workforce competitive. Although the ATE program focuses almost exclusively on two-year colleges, this is the fourth grant that the DNALC has received. Previous grants supported development and dissemination of experiments that illustrate key methods in biotechnology, as well as our survey of high school biotechnology education. Our long-time collaborator Linnea Fletcher, at Austin Community College, leads the project team. Our role is to develop a New York City Genomics Hub to support genome-based experiments in two-year colleges. The ATE hub will be based at the new DNALC at City Tech, in Brooklyn.



As part of this national center, we will develop a supply chain model that will dramatically reduce DNA sequencing costs and allow an unprecedented number of students to participate in authentic research. The genomics supply chain will entail lab, quality assurance, data science, and “soft” skills that will prepare students for successful careers in biotechnology. In this model, students at community colleges will learn key technical skills as they produce the products and services to support classroom experiments. Biotech students will learn while producing the reagents needed to isolate DNA, amplify the barcode region, and prepare it for sequencing. Students will not only produce reagents for their own programs, but also distribute kits for students in other community colleges and high schools. Advanced students will also assist their peers as “clients,” supporting them as they learn biochemistry and bioinformatics.

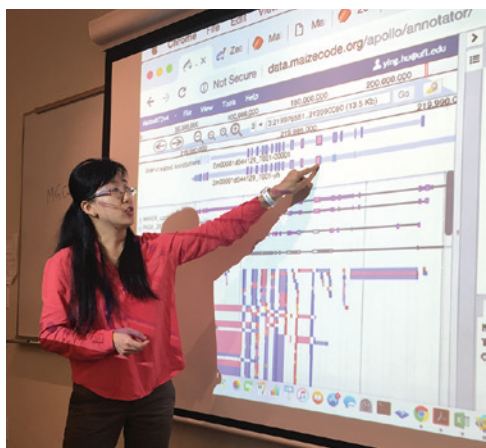
A crucial element of the system will be a student-staffed sequencing service, giving students real-world experience in the world of biological big data. Using approaches developed at the DNALC, the sequencing service will coordinate sequence submissions from classes around the country and stage them for cost-effective sequencing on machines run by students in community college biotechnology programs.

### NSF MaizeCODE

MaizeCODE continued developing data that will become an important resource for breeders and plant scientists. Our pilot study showed how to use MAKER-P quality scores and the alignments between a translated protein sequence and its homologs across species to identify errors in gene predictions\*. Student curators then corrected the flagged gene models using the Apollo annotation editor, and uploaded their corrections as a track on the Gramene genome browser.

As part of our outreach efforts on this project, the second and third Maize Annotation Jamborees were held January 10–11 at the Scripps Institution of Oceanography in San Diego, CA and March 13–14 at the Biology Department of Washington University in St. Louis, Missouri. We trained PUI faculty and researchers to use our genome annotation pipeline, with the objectives of integrating maize annotation CUREs and establishing a larger community curation effort to improve the *Zea mays* gene models. These efforts will continue via periodic meetings to discuss progress on the partnerships and providing assistance in developing bioinformatics lessons and wet lab resources that can be implemented in the classroom.

We presented the results of our annotation project at the XXVII Plant and Animal Genome Meeting in San Diego, CA (January), at the 61<sup>st</sup> Maize Genetics Conference in St. Louis, MO (March), at Middle Tennessee State University, Murfreesboro, TN (November), and the 11<sup>th</sup> CSHL Plant Genomes System Biology and Engineering Meeting in Cold Spring Harbor, NY (December).



Jamboree participants in San Diego (left) and St. Louis (below).



\*Tello-Ruiz MK, Marco CF, Hsu F-M, Khangura RS, Qiao P, Sapkota S, et al. (2019) Double triage to identify poorly annotated genes in maize: The missing link in community curation. PLoS ONE 14(10): e0224086. <https://doi.org/10.1371/journal.pone.0224086>

## Licensed Centers

We celebrated the official opening of the *Regeneron DNA Learning Center* in December. Located on Regeneron's Sleepy Hollow campus, this new 4,700 square foot facility has two teaching labs and a large prep lab with space specifically designed for assembling footlocker kits. The *Regeneron DNALC* is easily accessible to schools in Westchester, Rockland, and Putnam counties, as well as New Jersey and Connecticut. In our first month of operation in 2019, over 100 high school students visited for field trips, and reservations for an additional 1,500 students were made for spring 2020.

In 2019, 1,691 students from 42 different schools participated in hands-on molecular biology labs supported by the DNALC at Notre Dame (DNALC-ND). Under the leadership of director Dr. Amy Stark, instructional programs included lab field trips to the DNALC-ND, in-school instruction, and engagement at regional and state-level science fairs. Over 112 students, including two from Canada, participated in week-long residential and day camps.

## International Partnerships

### *DNALC Asia, Suzhou, China*

As part of our collaboration with *DNALC Asia* in Suzhou Industrial Park (SIP), we organized and interviewed candidates for a new Education Director after the departure of Jessica Talamas.

Finding the right person for this position was key, because we wanted an educator versed in the American style of instruction and prepared for the differences of life in China. We were very fortunate to recruit Dr. John Olson, a New York native who was already working a lecturer at Peking University. After training here at the DNALC, John started in Suzhou in August and worked to set up barcoding research projects at international schools and local universities.



Top left: Dr. John Olson. Lower left: Dr. Sharon Pepenella (center) trained 26 students working on biodiversity and consumer issue-focused projects during a two-week DNA barcoding research course at *DNALC Asia*.

*DNALC Asia* continued to ramp up its instructional capacity. In September and October, the Center saw 1,584 student visitors for on-site labs (vs. 307 in 2018) and taught 1,072 in local high schools (vs. 375 in 2018). The *DNALC Asia* "Young Biologist" program selects talented students in the life sciences and helps them develop skills in experimental biology. After six months of training, students independently complete a scientific poster, present their material to the public, then meet face-to-face with expert judges. The 2018-2019 program began in December of 2018 with 70 students and after two rounds of selection, 20 students were selected to participate in the final presentations in April.

The 2019-20 program began with 80 students in December. Training for SIP teachers brought in 30 high school and 26 middle school faculty who were trained to bring courses into the classroom. Overall, *DNALC Asia* offered individual courses with a total enrollment of 4,655 students in 2019.

### *Beijing 166, China*

Aiming to improve biology education at secondary schools in China, the DNALC established a licensed center at Beijing 166 in 2014. Under the collaboration contract, Beijing students and teachers come to New York to attend two- or three-week camps during the summer and winter; additionally, DNALC instructors conduct workshops in Beijing for total of four weeks in the spring and fall each year. In 2019, 299 BJ 166 students and 20 teachers attended DNALC camps and workshops. In April 2019, DNALC executive director Dave Micklos and international collaboration manager Catherine Zhang traveled with 112 Beijing students to biodiversity hot spots in southern China to collect samples for DNA barcoding research. Despite rainy weather, the students collected and developed DNA barcodes from 244 samples; 57 DNA sequences have been published in GenBank.



Amanda McBrien leads a Beijing 166 student camp in August.

The experiments in hands-on biology education and student research the DNALC has conducted at Beijing 166 are being noticed by innovative educators, especially at the international and foreign language schools in China. In December 2019, Dave was invited to visit schools at Shenzhen, Dongguan, and Suzhou, giving talks to a total of 750 educators, parents, and students. Two leading international schools—Tsinglan School and Shen Wai International School—intend to become DNALC partner schools in the near future.

### *DNA Learning Center Nigeria*

On Wednesday November 20<sup>th</sup>, a formal license to operate and host the *DNA Learning Center Nigeria* was awarded to Godfrey Okoye University (GOU) in Enugu state, Nigeria. This is the result of a multiyear collaboration between the DNALC and GOU, facilitated through our close collaborator, Dr. George Ude of Bowie State University. DNALC Scholar and NYU graduate Michael Okoro leads the project and oversaw the refurbishment of the new center. GOU Vice Chancellor Christian Anieke provided a dedicated building for the DNALC on the new GOU Ugwuomu campus. The DNALC provided the lab design and \$50,000 for equipment, including its signature lab table, as well continued salary support for Michael. Over the next year, the center will begin to offer programs that benefit students and teachers at GOU and colleges throughout Nigeria.

### **Dissemination at Professional Meetings**

As in previous years, we continued to disseminate our programs at meetings. We presented our Ötzi the Iceman activity and results from our Biotechnology in American High Schools research at NABT. DNALC staff presented DNA barcoding and metabarcoding at the Invertebrates in Education and Conservation Conference, International Plant and Animal Genome Conference (PAG), American Society for Microbiology Conference, Long Island Natural History Conference, Community College Undergraduate Experience Summit, NIH SEPA SciEd Conference, and NSF IUSE PI Conference. Our data science programs were also presented at PAG and BioCodigo de Barras Symposium, while our efforts to democratize science and science education were presented at the ISMB/ECCB Conference.

## Lab Instruction and Outreach

In 2019, 20,358 students attended lab field trips at our five facilities: Dolan DNA Learning Center, DNALC West, Harlem DNA Lab, Regeneron DNALC, and DNALC NYC at City Tech. In-school instruction programs reached 7,728 students and 1,157 students attended weeklong camps, including some three international campers from Mexico and Spain. Footlocker kits were used by 1,758 students, 262 of whom were conducting independent research through *UBP*, *UBRP*, or *BLL*.

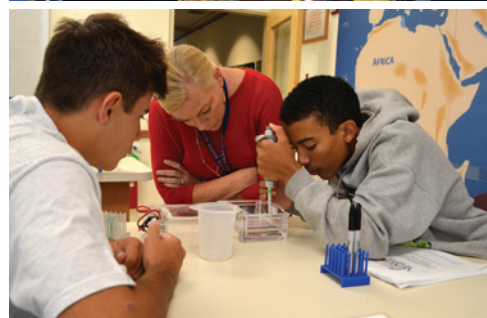
A grant from National Grid Foundation paid tuition for field trips and in-school instruction for 693 students from the Central Islip UFSD. An additional 1,105 students from other public school districts received scholarships—including Amityville, Brentwood, Malverne, Roosevelt, Uniondale, Connetquot, William Floyd, Ossining, and Valley Stream.

This year 2,667 (58%) of the students that attended field trips at *Harlem DNA Lab* and DNALC at City Tech, came from Title I schools that qualified for tuition assistance. The William Townsend Porter Foundation subsidized 20% of student scholarships for students visiting the *Harlem DNA Lab*. An additional 14 students from IS 59 in Queens received sequential lab instruction at DNALC West as part of an ongoing collaboration with Northwell Health.

The Partner Member Program continued to provide custom science sequences and advanced electives for seven independent schools in the tri-state region.

- Research teams from our newest member, Fontbonne Hall Academy, used DNA barcoding to create novel GenBank entries for flowering plants.
- Grace Church School offered a summer program that included using DNA barcoding to survey biodiversity of the plants and insects found near the school.
- At Marymount School of New York, genetics programs were incorporated as key parts of the biology curriculum, and students in molecular biology continued projects to analyze environmental DNA (eDNA) from NYC Parks and the Hudson River.
- Research teams from Sacred Heart Greenwich used DNA barcoding to identify shellfish in food products and confirm identity of sushi products. One team used next generation sequencing to analyze the effect of different ceramic surfaces on the microbiome.
- Lycée Français de New York continued to refine the 8<sup>th</sup> grade forensics elective and offered *Human Genomics* and *Green Genes* camps during the summer.
- The Chapin School implemented genetics programs at several grade levels, including the advanced *Molecular Genetics* elective.
- St. David's School integrated basic genetics and DNA barcoding programs with existing curricula in grades five and eight.

As part of ongoing local partnerships, eight students from St. Dominic High School received daily instruction by DNALC educators. Students enrolled in the *Molecular and Genomic Biology Research* course visited the DNALC each afternoon for customized lab experiences in DNA barcoding as well as DNA and *Genome Science*. DNALC educators also worked with 22 students from Cold Spring Harbor High School's 9<sup>th</sup> grade research program to do a survey of the biodiversity of Cold Spring Harbor using DNA barcoding. All students in both classes participated in the *Barcode Long Island* research program.



Cold Spring Harbor High School's research program students spent a day in September collecting barcoding samples in and around Cold Spring Harbor. Then they documented and prepared samples for DNA isolation at the DNALC.



National Geographic filmed archaeologist Patrick Hunt and DNALC's Lindsay Barone with our Ötzi replica in May for The "Iceman Murder Mystery: Lost in the Ice" documentary.

This year we had 5,041 visitors to the Ötzi the Iceman exhibit, either on its own or as part of a field trip. With the success of the Ötzi exhibit, we focused attention this year to completing the redesign of our additional exhibit space. Nine *Saturday DNA!* sessions drew 277 participants who learned about DNA isolation, crime scene analysis, genetically modified foods and gel electrophoresis, ancient humanity, the science of the five senses, genetic engineering, and Mendelian inheritance. A microbial masterpiece created at our fall Agar Art session won 1<sup>st</sup> place in the American Society for Microbiology (ASM) Agar Art Kids contest. In this workshop, participants learned how laboratory techniques that scientists commonly use to study the living world could also be used to create unique works of art. In addition, DNALC staff presented as part of the *SUBMERGE Science Festival* at Hudson River Park, *Student Conference on Conservation Science* at the American Museum of Natural History, Bronx Center for Science and Mathematics Career Fair, STEM Teachers NYC Expo, *Pine Barrens Discovery Day* at Wertheim National Wildlife Refuge, and *Saturday Science for Students* at the Explorer's Club in Manhattan.

We continued to work with recipients of the *Junior Breakthrough Challenge*, an international competition where young people submit short videos explaining big scientific ideas. Winners receive scholarships and a new lab for their school that is designed and equipped with help from the DNALC. This year we began work with the school of 2018 winner Samay Godika, the National Public School-Koramangala in Bangalore, India. The school building was already being refurbished, so a perfect time to plan a new lab space! We have provided some designs and will begin working with faculty to purchase equipment.

As part of our ongoing partnership with CSHL Women in Science and Engineering (WiSE), we hosted the third *WiSE Fun with DNA* summer camp. Held on the main campus of CSHL in Delbrück Laboratory, 21 young female science enthusiasts, two of whom received WiSE scholarships to attend, had the opportunity to meet and interact with enthusiastic female role models pursuing careers in the sciences. Each afternoon, the girls participated in WiSE activities on herd immunity, neuroscience, and astrophysics. They also took a "field trip" to Uplands Farm to tour the greenhouses and learn about the rich history of plant research at CSHL.

The DNALC has long been interested in reaching diverse audiences and communities and has made progress through scholarships and our locations in Harlem and Brooklyn. This year, we created a summer camp exclusively to reach URM students underrepresented in the sciences. The Science Technology AND Research Scholars (STARS) program is a two-week research



Left: Jason Williams leads a lab during week one. Right: STARS students during bioinformatics session in week two.



experience designed to support the next generation of minority scientists, doctors, and health professionals. STARS provides students with state-of-the-art laboratory and computer science skills needed to succeed in STEM in college and beyond. Led by DNALC Assistant Director Jason Williams and Middle School Educator Brittany Johnson, this program also involved collaboration with Dr. Carol Carter, a professor at Stony Brook University, Dr. Paul Lichtman, a research coordinator at Adelphi University, and David Johnson, a student from the CSHL graduate school. Together, this team designed a curriculum that exposed students to DNALC lab activities, guest lectures from CSHL graduate students and researchers, a tour of the Stony Brook University campus and medical school, and guidance on research opportunities.

The camp attracted 24 students from 15 school districts; 80% had not previously attended DNALC programs. After a Saturday orientation for the students and their families, the first week focused on lab work, and the second week focused on bioinformatics and computer coding. The experience concluded with students presenting their work to their families—with the goal of sharpening their science communication skills and educating their families on STEM careers. Several participants have gone on to pursue independent high school research projects. We hope that this program will become a key element of CSHL's growing commitment to generate a "pipeline" of minority students in STEM higher education and careers.

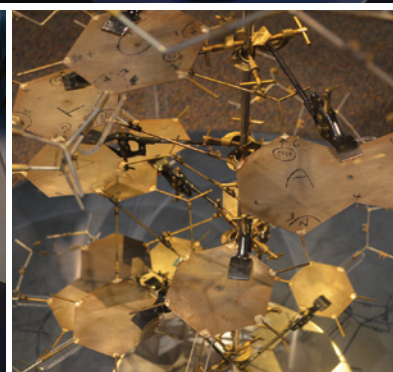
Our collaboration with the CSHL School of Biological Sciences continued with exposing graduate students to skills needed to communicate science to a variety of audiences. As part of their required curriculum, first year graduate students work with DNALC instructors to complete 12 half-day sessions in which they progress from classroom observation to lesson planning to co-instructing alongside a DNALC staff member to independent leading lab classes. Students learn classroom management skills—including how to quickly assess an audience and customize a presentation accordingly. Graduate students interact equally with both middle- and high-school-aged students during their required rotations, then complete three elective classes in which they implement their new skills.

### **BioMedia Visitation and Projects**

In 2019, 5.2 million visitors accessed our suite of multimedia resources. Google Analytics counted 3.7 million visits to DNALC websites, our YouTube videos received 883,944 views, and the *3D Brain*, *Weed to Wonder*, and *Gene Screen* smartphone/tablet apps were downloaded 590,471 times. In-app purchases of 3D Brain netted \$6,175 for the year.

We completed a total redesign the DNALC.org site, giving it a fresh look, better organization, and easier navigation. We worked with the Public Affairs Department to prepare for a seamless merger with the Cold Spring Harbor Laboratory ([www.cshl.edu](http://www.cshl.edu)) website by transitioning the DNALC site domain to <https://dnalc.cshl.edu>.

The *BioMedia* Group continued to support the educational objectives of the DNALC through web design and programming, print design, photography, videography, and lab classroom layout planning for collaborators around the world. We followed up on earlier development of *Our Human Inheritance*, a museum exhibit that features Ötzi the Iceman and ancient human ancestors in the main gallery space. Working on content and design with DNALC educators, the *BioMedia* staff completed displays for the rear gallery in December. Similar to the large mural of the Italian Alps in the Ötzi exhibit, the focal point of the new display is a stunning floor-to-ceiling, 30-foot long image of the universe that serves as a backdrop for a timeline of the history of life on Earth and some of the key developments that have allowed life to flourish on our planet. In an exploration of the processes and outcomes of evolution, the exhibit showcases the evolution of the eye—from a simple light detecting eyespot to the compound eye. Additionally, several interesting human evolution stories connect the new space to the existing exhibits on human ancestry. A touchscreen with an interactive chromosome map



enables students to explore the human genome one gene at a time. Finally, an interactive human variation wall highlights how traits manifest themselves in different people—holding a literal mirror up to our visitors and allowing them to explore some of their own traits.

## Staff and Interns

During the year, the DNALC staff was strengthened by the addition of Brittany Johnson, Justin Burke, Jennifer Hackett, Ph.D., Louise Bodt, Lina Bader, and Lina Ruiz-Grajales to the education and instruction staff, and Daniel Jacobs to the *BioMedia* Group.

Brittany Johnson started in January as a middle school educator. A native of Long Island, Brittany remembers visiting the DNALC as a child and being captivated by the “Mystery of Anastasia. She received a B.A. in biology from Fisk University and a Master of Biological Medical Sciences from Mississippi College. While volunteering in the Central Islip School, Brittany met a DNALC educator who had come to provide an in-school lab. Brittany pitched in with the class, impressed us, and was offered the next vacant position.

Justin Burke joined the DNALC in February as our lab technician. He is responsible for testing, assembling, and organizing supplies and reagents for all DNALC instruction, as well as managing our high school and college intern programs. Justin is a native Long Islander and has been interested in science his whole life. His work at the DNALC is preparing him to return to his studies of biochemistry and cell biology at Stony Brook University.

In June Daniel Jacobs joined our *BioMedia* Group as a programmer charged with maintaining, designing, and updating bioinformatics tools for our popular *DNA Subway* website. Daniel's interest in coding began in high school. He initially studied physics at Adelphi University then transferred to Queens College and earned his computer science degree. While there, he became “multilingual” in programming languages and learned Python to help with research on factors affecting the sustainability of world peace.

Jennifer Hackett joined our NYC education team in July. Jenny attended DePauw University where she developed her passion for science through research in the Science Research Fellows Program, including as part of the team that discovered the gene for frontotemporal dementia. She completed her Ph.D. thesis at Johns Hopkins University School of Medicine, where she studied the role of telomere dysfunction with Nobel laureate and former CSHL researcher Carol Greider. While developing shRNA libraries for genome-wide screens as a postdoc at Harvard Medical School, she volunteered with programs for children through Boston Cares. This motivated her to join the NYC Teaching Fellows and teach ultimately teach science at the prestigious Dalton School in Manhattan. She also consulted on the creation of BSCS/NIH curriculum supplements and is the author of *Molecular Biology: Concepts for Inquiry*, a high school textbook and curriculum.

Louise Bodt started in August as an educator and *UBP* manager based out of our City Tech temporary lab. A Brooklyn native, Louise participated in science classes and internships at the American Museum of Natural History (AMNH) during high school, which sparked her interest in genetics. She earned a B.A. from Smith College where she studied molecular biology and worked in a parasitology lab. After three years teaching science at two NYC private schools, she taught at the AMNH while receiving her M.S. in Biology from NYU, where she focused on the population genetics of European starlings.

Lina Bader joined the DNALC as an instructor for *Regeneron DNALC*. After a Bachelor's degree in biology from the University of Pennsylvania and graduate program for education, Lina taught biology at a Philadelphia public school. Although she loved classroom teaching, she was limited in her desire to implement lab teaching in molecular genetics. Being familiar with DNALC resources, Lina jumped at the opportunity to join the DNALC team.



From top left: Brittany Johnson, Justin Burke, Daniel Jacobs, Jenny Hackett, Louise Bodt, Lina Ruiz-Grajales, and Lina Bader.

Lina Ruiz-Grajales joined the DNALC in November as an instructor for *Regeneron DNALC*. After four years as a pharmaceutical chemistry student at the University of Antioquia in Colombia, she moved to New York and enrolled at Purchase College, where she studied the effects of climate on the model plant, *Arabidopsis thaliana*. As an Amgen summer scholar at UC Berkeley, she explored the role of the plant microbiomes in protection against plant pathogens. Her strong research background and knowledge of metabarcoding made her a natural to help with our student research programs using DNA barcodes.

We said goodbye to three staff members in 2019: genetics educators Alison Cucco and Pauline McGlone and *Urban Barcode Project* manager Christine Marizzi.

After eight fruitful years at the DNALC, Christine Marizzi accepted a position in September as a lead community scientist at BioBus. Christine started as manager of DNALC *West*, but quickly took on management of our two barcoding projects in New York City: *UBP* and *UBRP*. Christine did it all, from recruiting student researchers and faculty mentors to organizing the annual symposia for 500+ participants. She brought her strong love of citizen science to the DNALC, initiating our collaboration with Genspace and organizing a monumental “agar art” map of Manhattan that garnered worldwide attention.

In the spring Pauline McGlone earned a Master’s degree in healthcare administration from Hofstra University and accepted a position as a project associate at NYU Langone. Pauline started her journey at the DNALC as a high school intern in 2012. While attending college locally, Pauline continued to work as a college intern. She embraced this learning experience, which helped her with college biology courses and required labs. After interning for five years, Pauline came full circle—transitioning to a middle school educator who taught the labs she had prepped as an intern.

Alison Cucco left the DNALC in the spring to become environmental compliance coordinator for PSE&G. Alison was an educator for the *Harlem DNA Lab* and Partner Member schools. She provided customized in-school instruction, and assisted with student barcoding projects, including a pilot program using environmental DNA to monitor the health of the Hudson River Estuary.

Since the DNALC opened, we have relied on high school and college interns to support our day-to-day operations. An internship offers students the unique opportunity to gain real laboratory or design experience in an educational environment. We gathered an amazing group of interns this year, and said farewell as others left for college:

#### *High School Interns*

Jacqueline Albert, Syosset High School	Sarah Nace, Walt Whitman High School
Christopher Catalano, Garden City High School	Jack O'Hara, St. Anthony's High School
Christopher Cizmeciyan, Syosset High School	Julia Padro, Grace Church School
Kaela Deriggi, St. Anthony's High School	Aveline Roderick, St. Anthony's High School
Thomas Kamara, All Hallows High School	Mina Samaras, Plainedge High School
Brady Lyons, St. Dominic High School	Samantha Sgrizzi, Huntington High School
Ethan McGuinness, Huntington High School	Esha Sharma, Syosset High School
James McKechnie, Northport High School	Michael Stabile, Plainedge High School
Ava Maiella, Harborfields High School	Nicholas Stabile, Plainedge High School
Sonja Michaluk, Hopewell Valley Central High School	Alejandro Wiltshire, St. Mary's High School

#### *High School Interns Departing for College*

Yusiry Acevedo Nunez, Farmingdale State College	Randy Diaz Arias, University of Rochester
Gavin Calabretta, Cornell University	Sibelle O'Donnell, University of Southern California
Elijah Calle, University of Buffalo	

#### *College Interns*

Nadia Alomari, New York City College of Technology	Jillian Maturo, Boston College
Gabrielle Blazich, Fordham University	William McBrien, Stony Brook University
Taehwan Cha, New York University	Katherine Parra, New York City College of Technology
Megan Erhardt, University of New Haven	Joni Sebastiano, Stony Brook University
Omotayo Ikuomenisan, Hunter College	Jon Triscari, University of Rochester
Isabella Martino, Stony Brook University	

**David Micklos**  
DNA Learning Center Executive Director

## 2019 Grants

Grantor	Program	Duration of Grant	2019 Funding <sup>+</sup>
<i>FEDERAL GRANTS</i>			
National Institutes of Health	<i>Barcode Long Island</i>	7/14–3/21	135,178
National Science Foundation	<i>Biotechnology in American High Schools: Continuing Research</i>	9/18–8/19	28,048
National Science Foundation	<i>Implementing DNA Barcoding for Course-Based Undergraduate Research Experiences</i>	10/18–9/23	229,880
National Science Foundation	<i>MaizeCODE: An Initial Analysis of Functional Elements in the Maize Genome</i>	6/16–5/19	160,603
National Science Foundation	<i>CyVerse: Cyberinfrastructure for the Life Sciences</i>	8/18–7/23	187,183
National Science Foundation	<i>The iPlant Collaborative: Cyberinfrastructure for the Life Sciences</i>	9/13–8/19	171,068
National Science Foundation	<i>RCN-UBE: Establishing a Genomics Education Alliance: Steps Towards Sustainability</i>	9/18–8/20	45,107
National Science Foundation	<i>InnovATEBIO National Biotechnology Education Center</i>	10/19–9/24	0
<i>NON-FEDERAL GRANTS</i>			
Alfred P. Sloan Foundation	<i>DNA Center NYC Start-up</i>	6/18–6/21	57,244
Beijing No. 166 High School	Chinese Collaboration Agreement	7/19–6/22	23,161
Breakthrough Prize Foundation	Laboratory Design and Teacher Training for Breakthrough Junior Challenge Prize Winners	12/15–12/19	7,625
Health Park	Health Park Agreement	12/15–12/20	7,491
National Grid Foundation	Genetics Education Program	7/19–6/20	0
Pinkerton Foundation	<i>Urban Barcode Research Program</i>	1/19–5/20	93,532
Richard Lounsbery Foundation	Developing Independent Student Marine Biodiversity Research Using eDNA	10/17–6/20	6,024
The Simons Foundation	<i>Urban Barcode Research Program</i>	12/17–8/20	104,410
William Townsend Porter Foundation	<i>Harlem DNA Lab for Underprivileged Students</i>	1/19–1/20	13,500
Nature's Bounty Foundation	Vitamin Engineering Lab	8/18–11/19	25,000
New York Harbor Foundation, Inc.	Billion Oyster Project	3/19–9/19	6,000

+ Includes direct and indirect costs.

The following schools and school districts each contributed \$1,000 or more for participation in the *Curriculum Study* program:

Bellmore-Merrick Central High School District	\$3,500	Long Beach Union Free School District	\$3,150
East Meadow Union Free School District	\$3,500	Massapequa Union Free School District	\$3,150
Elwood Union Free School District	\$2,100	North Shore Central School District	\$2,100
Fordham Preparatory School	\$2,100	Oceanside Union Free School District	\$2,100
Half Hollow Schools Central School District	\$2,100	Oyster Bay-East Norwich Central School District	\$2,100
Harborfields Central School District	\$2,100	Plainview-Old Bethpage Central School District	\$2,100
Herricks Union Free School District	\$2,100	Portledge School	\$3,150
Island Trees Union Free School District	\$2,100	Port Washington Union Free School District	\$2,100
Jericho Union Free School District	\$3,500	Roslyn Union Free School District	\$2,100
Levittown Union Free School District	\$2,100	Syosset Central School District	\$3,500
Locust Valley Central School District	\$2,100	Yeshiva University High School for Girls	\$2,100

The following schools and school districts each contributed \$1,000 or more for participation in the *Genetics as a Model for Whole Learning* program:

Baldwin Union Free School District	\$1,600	Jericho Union Free School District	\$15,158
Bayshore Union Free School District	\$4,240	Kings Park Union Free School District	\$3,500
Bellmore Union Free School District	\$10,500	Lawrence Union Free School District	\$3,200
Berkeley Carroll School	\$2,500	Locust Valley Central School District	\$3,750
Bethpage Union Free School District: Century 21 Program	\$1,050	Long Island School for the Gifted	\$1,150
Bridges Academy	\$1,470	Merrick Union Free School District	\$3,000
Cambria School of Excellence, Inc.	\$1,500	North Bellmore Union Free School District	\$5,347
Center Moriches Union Free School District	\$1,400	New York City Department of Education	\$12,960
Cold Spring Harbor Central School District	\$14,437	Oceanside Union Free School District	\$2,520
Columbia Grammar and Preparatory School	\$1,650	Our Lady of Lourdes, Malverne	\$1,470
Commack Union Free School District	\$1,600	Oyster Bay- East Norwich Central School District	\$1,225
East Meadow Union Free School District	\$1,050	Plainedge Union Free School District	\$1,200
East Williston Union Free School District	\$1,800	Rockville Centre Union Free School District	\$4,125
Elwood Union Free School District	\$5,550	Roslyn Union Free School District	\$6,300
Floral Park- Bellerose Union Free School District	\$8,650	Smithtown Union Free School District	\$10,275
Garden City Union Free School District	\$21,585	South Huntington Union Free School District	\$7,600
Great Neck Union Free School District	\$22,800	St. Agnes Cathedral School	\$1,375
Green Vale School	\$2,300	St. Patricks School (Huntington)	\$3,900
Greenwich Country Day School	\$4,125	Syosset Union Free School District	\$6,875
Hicksville Union Free School District	\$1,600	Three Village Central School District	\$7,225
Hofstra STEP	\$1,100	Trevor Day School	\$2,300
Huntington Union Free School District	\$10,125	Wantagh Union Free School District	\$1,600

## Sites of Major Faculty Workshops

Program Key: *Middle School* High School College

State	Institution	Year(s)
ALABAMA	University of Alabama, Tuscaloosa	1987–90
	<b>Hudson Alpha Institute, Huntsville</b>	<b>2014</b>
ALASKA	<b>University of Alaska, Anchorage</b>	<b>2012</b>
	<b>University of Alaska, Fairbanks</b>	<b>1996</b>
ARIZONA	Arizona State University, Tempe	2009
	Tuba City High School	1988
	<b>University of Arizona, Tucson</b>	<b>2011, 2019</b>
	<b>United States Department of Agriculture, Maricopa</b>	<b>2012</b>
ARKANSAS	Henderson State University, Arkadelphia	1992
	<b>University of Arkansas, Fayetteville</b>	<b>2017, 2019</b>
	<b>University of Arkansas, Little Rock</b>	<b>2012</b>
	<b>University of Arkansas for Medical Sciences, Little Rock</b>	<b>2019</b>
CALIFORNIA	<b>California State University, Dominguez Hills</b>	<b>2009</b>
	<b>California State University, Fullerton</b>	<b>2000</b>
	<b>California State University, Long Beach</b>	<b>2015</b>
	<b>California Institute of Technology, Pasadena</b>	<b>2007</b>
	<b>Chan-Zuckerberg BioHub, San Francisco</b>	<b>2018</b>
	Canada College, Redwood City	1997
	City College of San Francisco	2006
	<b>City College of San Francisco</b>	<b>2011, 2013</b>
	Contra Costa County Office of Education, Pleasant Hill	2002, 2009
	<b>Foothill College, Los Altos Hills</b>	<b>1997</b>
	Harbor-UCLA Research & Education Institute, Torrance	2003
	<b>Los Angeles Biomedical Research Institute (LA Biomed), Torrance</b>	<b>2006</b>
	Laney College, Oakland	1999
	Lutheran University, Thousand Oaks	1999
	Oxnard Community College, Oxnard	2009
	<b>Pasadena City College</b>	<b>2010</b>
	<b>Pierce College, Los Angeles</b>	<b>1998</b>
	Salk Institute for Biological Studies, La Jolla	2001, 2008
	<b>San Francisco State University</b>	<b>1991</b>
	<b>San Diego State University</b>	<b>2012</b>
	<b>San Jose State University</b>	<b>2005</b>
	Santa Clara University	2010
	<b>Scripps Institute, San Diego</b>	<b>2019</b>
	<b>Southwestern College, Chula Vista</b>	<b>2014–15</b>
	<b>Stanford University, Palo Alto</b>	<b>2012</b>
	<b>University of California, Berkeley</b>	<b>2010, 2012</b>
	University of California, Davis	1986
	<b>University of California, Davis</b>	<b>2012, 2014–15</b>
	<b>University of California, Long Beach</b>	<b>2015</b>
	<b>University of California, Northridge</b>	<b>1993</b>
	University of California, Riverside	2011
	<b>University of California, Riverside</b>	<b>2012</b>
	<b>University of California, San Francisco</b>	<b>2015</b>
COLORADO	Aspen Science Center	2006
	Colorado College, Colorado Springs	1994, 2007
	<b>Colorado State University, Fort Collins</b>	<b>2013, 2018</b>



	<b>Community College of Denver</b>	<b>2014</b>
	<b>United States Air Force Academy, Colorado Springs</b>	<b>1995</b>
	University of Colorado, Denver	1998, 2009–10
CONNECTICUT	Choate Rosemary Hall, Wallingford	1987
	<b>Jackson Laboratory, Farmington</b>	<b>2016</b>
DELAWARE	<b>University of Delaware, Newark</b>	<b>2016</b>
DISTRICT OF COLUMBIA	<b>Howard University, Washington</b>	<b>1992, 1996, 2009–10</b>
FLORIDA	Armwood Senior High School, Tampa	1991
	Florida Agricultural & Mechanical University, Tallahassee	2007–08
	<b>Florida Agricultural &amp; Mechanical University, Tallahassee</b>	<b>2011</b>
	<b>Florida SouthWestern State University, Fort Myers</b>	<b>2015</b>
	North Miami Beach Senior High School	1991
	<b>Seminole State College, Sanford</b>	<b>2013–14</b>
	University of Florida, Gainesville	1989
	University of Miami School of Medicine	2000
	University of Western Florida, Pensacola	1991
GEORGIA	Fernbank Science Center, Atlanta	1989, 2007
	<b>Gwinnett Technical College, Lawrenceville</b>	<b>2011–12</b>
	<b>Morehouse College</b>	<b>1991, 1996</b>
	Morehouse College	1997
	<b>Spelman College, Atlanta</b>	<b>2010</b>
	<b>University of Georgia, Athens</b>	<b>2015</b>
HAWAII	Kamehameha Secondary School, Honolulu	1990
	<b>University of Hawaii at Manoa</b>	<b>2012</b>
IDAHO	University of Idaho, Moscow	1994
ILLINOIS	Argonne National Laboratory	1986–87
	iBIO Institute/Harold Washington College, Chicago	2010
	Illinois Institute of Technology, Chicago	2009
	<b>Kings College, Chicago</b>	<b>2014</b>
	<b>University of Chicago</b>	<b>1992, 1997, 2010</b>
	<b>University of Southern Illinois, Carbondale</b>	<b>2016</b>
INDIANA	Butler University, Indianapolis	1987
	<b>Purdue University, West Lafayette</b>	<b>2012</b>
IOWA	Drake University, Des Moines	1987
KANSAS	University of Kansas, Lawrence	1995
KENTUCKY	<b>Bluegrass Community &amp; Technical College, Lexington</b>	<b>2012–14</b>
	Murray State University	1988
	University of Kentucky, Lexington	1992
	Western Kentucky University, Bowling Green	1992
LOUISIANA	Bossier Parish Community College	2009
	Jefferson Parish Public Schools, Harvey	1990
	John McDonogh High School, New Orleans	1993
	<b>Southern University at New Orleans</b>	<b>2012</b>
	<b>University of New Orleans</b>	<b>2018</b>
MAINE	Bates College, Lewiston	1995
	<b>Southern Maine Community College</b>	<b>2012–13</b>
	Foundation for Blood Research, Scarborough	2002
MARYLAND	Annapolis Senior High School	1989
	<b>Bowie State University</b>	<b>2011, 2015</b>
	Frederick Cancer Research Center	1995
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools	1990–92

	National Center for Biotechnology Information, Bethesda	2002
	<i>St. John's College, Annapolis</i>	1991
	<b>University of Maryland, School of Medicine, Baltimore</b>	<b>1999</b>
MASSACHUSETTS	<b>Arnold Arboretum of Harvard University, Roslindale</b>	<b>2011</b>
	Beverly High School	1986
	Biogen Idec, Cambridge	2002, 2010
	<b>Boston University</b>	<b>1994, 1996</b>
	CityLab, Boston University School of Medicine	1997
	Dover-Sherborn High School, Dover	1989
	Randolph High School	1988
	The Winsor School, Boston	1987
	Whitehead Institute for Biomedical Research, Cambridge	2002
MICHIGAN	Athens High School, Troy	1989
	<b>Schoolcraft College, Livonia</b>	<b>2012</b>
MINNESOTA	<b>American Society of Plant Biologists, Minneapolis</b>	<b>2015</b>
	Minneapolis Community and Technical College, Madison	2009
	<b>Minneapolis Community and Technical College, Madison</b>	<b>2013</b>
	University of Minnesota, St. Paul	2005
	<b>University of Minnesota, St. Paul</b>	<b>2010</b>
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990–91
	<b>Rust College, Holly Springs</b>	<b>2006–08, 2010</b>
MISSOURI	<b>St. Louis Science Center</b>	<b>2008–10</b>
	Stowers Institute for Medical Research, Kansas City	2002, 2008
	<b>University of Missouri, Columbia</b>	<b>2012</b>
	Washington University, St. Louis	1989
	<b>Washington University, St. Louis</b>	<b>1997, 2011, 2019</b>
MONTANA	<b>Montana State University, Bozeman</b>	<b>2012</b>
NEBRASKA	<b>University of Nebraska-Lincoln, Lincoln</b>	<b>2014</b>
NEVADA	University of Nevada, Reno	1992, 2014
NEW HAMPSHIRE	Great Bay Community College, Portsmouth	2009
	<b>New Hampshire Community Technical College, Portsmouth</b>	<b>1999</b>
	St. Paul's School, Concord	1986–87
NEW JERSEY	Coriell Institute for Medical Research, Camden	2003
	Raritan Valley Community College, Somerville	2009
NEW MEXICO	Biolink Southwest Regional Meeting, Albuquerque	2008
	<b>Los Alamos National Lab</b>	<b>2017</b>
	<b>New Mexico State University, Las Cruces</b>	<b>2017</b>
	<b>Santa Fe Community College, Santa Fe</b>	<b>2015</b>
NEW YORK	Albany High School	1987
	American Museum of Natural History, New York	2007, 2015
	Bronx High School of Science	1987
	Brookhaven National Laboratory, Upton	2015–18
	Canisius College, Buffalo	2007
	<b>Canisius College, Buffalo</b>	<b>2011</b>
	City College of New York	2012
	Cold Spring Harbor High School	1985, 1987
	<b>Cold Spring Harbor Laboratory</b>	<b>2014–15, 2018–19</b>
	<b>Columbia University, New York</b>	<b>1993</b>
	<b>Cornell University, Ithaca</b>	<b>2005</b>
	<i>DeWitt Middle School, Ithaca</i>	1991, 1993
	Dolan DNA Learning Center	1988–95, 2001–04, 2006–09, 2015–19
	<b>Dolan DNA Learning Center</b>	<b>1990, 1992, 1995, 2000–11</b>

	<i>Dolan DNA Learning Center</i>	1990–92
	DNA Learning Center West	2005
	<i>DNA Learning Center NYC</i>	2019
	Environmental Science Center, Bergen Beach, Brooklyn	2015–16
	<i>Fostertown School, Newburgh</i>	1991
	<i>Harlem DNA Lab, East Harlem</i>	2008–09, 2011–13, 2016–19
	<b>Harlem DNA Lab, East Harlem</b>	<b>2015–16</b>
	Huntington High School	1986
	Irvington High School	1986
	K-12 Summer Institute, Kerrville	2019
	John Jay College of Criminal Justice	2009
	<i>Junior High School 263, Brooklyn</i>	1991
	<i>Lindenhurst Junior High School</i>	1991
	<b>Math for America</b>	<b>2017–19</b>
	Michel J. Petrides School, Staten Island	2018
	Mount Sinai School of Medicine, New York	1997
	<b>Nassau Community College, Garden City</b>	<b>2013</b>
	<b>New York Botanical Garden, Bronx</b>	<b>2013</b>
	New York City Department of Education	2007, 2012
	New York City Technical College (City Tech)	2018
	New York Institute of Technology, New York	2006
	<b>New York Institute of Technology, New York</b>	<b>2006</b>
	<i>Orchard Park Junior High School</i>	1991
	<i>Plainview-Old Bethpage Middle School</i>	1991
	<b>Regeneron Pharmaceuticals, Inc</b>	<b>2019</b>
	<b>School of Visual Arts, New York</b>	<b>2017</b>
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–90, 2015–18
	<b>State University of New York, Stony Brook</b>	<b>2014, 2016</b>
	Stuyvesant High School, New York	1998–99
	The Rockefeller University, New York	2003, 2015–16
	<b>The Rockefeller University, New York</b>	<b>2010</b>
	<i>Titusville Middle School, Poughkeepsie</i>	1991, 1993
	Trudeau Institute, Saranac Lake	2001
	Union College, Schenectady	2004
	<b>United States Military Academy, West Point</b>	<b>1996</b>
	Wheatley School, Old Westbury	1985
NORTH CAROLINA	CIIT Center for Health Research, Triangle Park	2003
	<b>North Carolina Agricultural &amp; Technical State University, Greensboro</b>	<b>2006–07, 2009–11</b>
	North Carolina School of Science, Durham	1987
	<b>North Carolina State University, Raleigh</b>	<b>2012, 2018</b>
NORTH DAKOTA	<b>North Dakota State University, Fargo</b>	<b>2012</b>
OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	Langston University, Langston	2008
	North Westerville High School	1990
	<b>The Ohio State University, Wooster</b>	<b>2016</b>
OKLAHOMA	<b>Oklahoma City Community College</b>	<b>2000</b>
	Oklahoma City Community College	2006–07, 2010
	Oklahoma Medical Research Foundation, Oklahoma City	2001
	Oklahoma School of Science and Math, Oklahoma City	1994
	Tulsa Community College, Tulsa	2009

	<b>Tulsa Community College, Tulsa</b>	<b>2012–14</b>
OREGON	Kaiser Permanente-Center for Health Research, Portland	2003
	<b>Linfield College, McMinnville</b>	<b>2014</b>
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy	1988
	Kimmel Cancer Center, Philadelphia	2008
RHODE ISLAND	Botanical Society of America, Providence	2010
SOUTH CAROLINA	<b>Clemson University</b>	<b>2004, 2015</b>
	Medical University of South Carolina, Charleston	1988
	<b>University of South Carolina, Columbia</b>	<b>1988</b>
SOUTH DAKOTA	<b>South Dakota State University, Brookings</b>	<b>2015</b>
TENNESSEE	NABT Professional Development Conference, Memphis	2008
TEXAS	Austin Community College – Rio Grande Campus	2000
	<b>Austin Community College – Eastview Campus – Roundrock Campus</b>	<b>2007–09, 2013</b>
	<b>Austin Community College – Roundrock Campus</b>	<b>2012</b>
	<b>Austin Community College - Austin</b>	<b>2018</b>
	<b>Houston Community College Northwest</b>	<b>2009–10</b>
	J.J. Pearce High School, Richardson	1990
	Langham Creek High School, Houston	1991
	<b>University of Lone Star College, Kingwood</b>	<b>2011</b>
	Midland College	2008
	Southwest Foundation for Biomedical Research, San Antonio	2002
	Taft High School, San Antonio	1991
	<b>Texas A&amp;M University, College Station, TX</b>	<b>2013</b>
	<b>Texas A&amp;M University, Prairie View, TX</b>	<b>2013</b>
	Texas A & M, AG Research and Extension Center, Weslaco	2007
	<b>Trinity University, San Antonio</b>	<b>1994</b>
	<b>University of Texas, Austin</b>	<b>1999, 2004, 2010, 2012</b>
	<b>University of Texas, Brownsville</b>	<b>2010</b>
UTAH	<b>Brigham Young University, Provo</b>	<b>2012</b>
	University of Utah, Salt Lake City	1993
	<b>University of Utah, Salt Lake City</b>	<b>1998, 2000</b>
	<b>Utah Valley State College, Orem</b>	<b>2007</b>
VERMONT	University of Vermont, Burlington	1989
	Champlain Valley Union High School	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	<b>James Madison University, Harrisonburg</b>	<b>2017</b>
	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
	<b>Virginia Polytechnic Institute and State University, Blacksburg</b>	<b>2005, 2008–09</b>
WASHINGTON	Fred Hutchinson Cancer Research Center, Seattle	1999, 2001, 2008
	Shoreline Community College	2011, 2012
	<b>University of Washington, Seattle</b>	<b>1993, 1998, 2010</b>
WEST VIRGINIA	<b>Bethany College</b>	<b>1989</b>
WISCONSIN	Blood Center of Southeastern Wisconsin, Milwaukee	2003
	<b>Madison Area Technical College/Madison Area College</b>	<b>1999, 2009, 2011–14</b>
	Marquette University, Milwaukee	1986–87
	University of Wisconsin, Madison	1988–89
	<b>University of Wisconsin, Madison</b>	<b>2004, 2012</b>
WYOMING	University of Wyoming, Laramie	1991
PUERTO RICO	<b>Universidad del Turabo, Gurabo, Puerto Rico</b>	<b>2011, 2012, 2014</b>

	University of Puerto Rico, Mayaguez	1992
	<b>University of Puerto Rico, Mayaguez</b>	<b>1992</b>
	<b>University of Puerto Rico, Rio Piedras</b>	<b>1993</b>
	University of Puerto Rico, Rio Piedras	1994
	<b>University of Puerto Rico, San Juan</b>	<b>2019</b>
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AUSTRALIA	Walter and Eliza Hall Institute and University of Melbourne	1996
	<b>EMBL/Australian Bioinformatics Resource, University of Melbourne</b>	<b>2016</b>
	<b>University of Western Australia, Perth</b>	<b>2018</b>
AUSTRIA	<b>Vienna Open Lab, Vienna</b>	<b>2007, 2012</b>
	<b>Technical University of Graz</b>	<b>2019</b>
CANADA	Red River Community College, Winnipeg, Manitoba	1989
	<b>University of Quebec, Montreal</b>	<b>2018</b>
CHINA	Beijing No. 166 High School, Beijing	2013–19
	<b>Ho Yu College, Hong Kong</b>	<b>2009</b>
DENMARK	<b>Faroe Genome Project, Torshavn, Faroe Islands</b>	<b>2013</b>
GERMANY	Urania Science Center, Berlin	2008
IRELAND	<b>European Conference on Computational Biology/Intelligent System for Molecular Biology Conference, Dublin</b>	<b>2015</b>
	<b>University College Dublin</b>	<b>2018</b>
ITALY	International Institute of Genetics and Biophysics, Naples	1996
	Porto Conte Research and Training Laboratories, Alghero	1993
MEXICO	ADN Mexico, Morelia	2016
	ASPB Plant Biology, Mérida	2008
	<b>Langebio/Cinvestav, Irapuato</b>	<b>2016</b>
NIGERIA	Godfrye Okoye University, Enugu, Nigeria	2013, 2018
PANAMA	<b>University of Panama, Panama City</b>	<b>1994</b>
PHILIPPINES	Eastern Visayas Campus, Philippine Science High School, Palo, Leyte	2017
RUSSIA	Shemyakin Institute of Bioorganic Chemistry, Moscow	1991
SINGAPORE	National Institute of Education	2001–05
	Singapore Science Center	2013
SOUTH AFRICA	<b>North-West University, Potchefstroom</b>	<b>2016</b>
	<b>South African Bioinformatics Society, Durban</b>	<b>2016</b>
SWEDEN	Kristineberg Marine Research Station, Fiskebackgkil	1995
	Uppsala University	2004
THE NETHERLANDS	<b>International Chromosome Conference, Amsterdam</b>	<b>2007</b>
	<b>Wageningen University and Research Center, Wageningen</b>	<b>2014</b>
UNITED KINGDOM	<b>Earlham Institute, Norwich</b>	<b>2018</b>
	<b>The Genome Analysis Center, Norwich</b>	<b>2015</b>
	<b>University of York, York</b>	<b>2017</b>
	<b>Wellcome Trust Conference Center, Hinxton</b>	<b>2012–13</b>
	<b>University of Warwick, Coventry</b>	<b>2013</b>

**Workshops, Meetings, Collaborations, and Site Visits**

- January 7-8 Software Carpentry Workshop, University of Arkansas, Fayetteville, Arkansas
- January 10-11 Maize Annotation Jamboree, Scripps Institute of Oceanography, San Diego, California
- January 11 The Central Pine Barrens Cooperators Meeting, Hyatt Place Long Island/East End, Riverhead, New York
- January 12 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- January 12-16 International Plant and Animal Genome XXVII Conference 2019, CyVerse Education Sessions: "CyVerse Software, Tools, and Services for Data-Driven Discovery, Data Science, and Education," "Advanced Computational Methods - Machine Learning, Containers, and Clouds," "Biochemical and Bioinformatics Infrastructure to Support Metabarcoding CUREs," San Diego, California
- January 17 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- January 19 *Saturday DNA!* "Enzymes in Action," DNALC
- January 22 NIH *Barcode Long Island* Open Lab, DNALC  
*Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- January 25 Site visit by Armando Barriguete and Hugo Scherer, Mexico DNA Learning Center Development, Mexico City, Mexico
- January 30 Site visit by Vision Gifted Chinese Children's School, Shenzhen, China
- January 31 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- February 1 RNA-Seq With DNA Subway Webinar, DNALC
- February 2 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- February 7 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- February 8 *DNA Barcoding* Teacher Workshop, DNALC NYC at City Tech
- February 9 *Saturday DNA!* "BioArt" DNALC  
Ötzi the Iceman Tour, DNALC
- February 11-22 *DNA Science, DNA Barcoding* and Research Workshops, Beijing 166 School, DNALC
- February 12 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- February 19-20 Go Fish - eDNA Teacher Workshop, Pier 84, New York, New York
- February 19-22 *Urban Barcode Research Program Conservation Genetics* Workshop, *Harlem DNA Lab*
- February 25 Arkansas Bioinformatics Consortium Annual Meeting, "CyVerse Cyberinfrastructure for Research and Education in Genomics and Metagenomics," University of Arkansas for Medical Sciences, Little Rock, Arkansas
- February 28 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- March 2 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- March 8 Site visit by Passaic County Community College Delegation, Paterson, New Jersey
- March 9 NIH *Barcode Long Island* Open Lab, Stony Brook University, Stony Brook, New York
- March 9 Intrepid Outreach Day, "Considering eDNA," Intrepid Sea, Air & Space Museum, Pier 86, New York
- March 12 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- March 13-14 Maize Annotation Jamboree, Washington University, St. Louise, Missouri
- March 14-17 Maize Genetics Conference, "Evaluating Community Curation Approaches for Improving Annotation on Classical Maize Gene Models," Poster Session, Washington University, St. Louis, Missouri
- March 16 NIH *Barcode Long Island* Open Lab, Brookhaven National Laboratory, Upton, New York  
*Saturday DNA!* "Ancient Ancestry," DNALC  
Ötzi the Iceman Tour, DNALC
- March 21 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- March 26 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- Mar 27-Apr 14 *DNA Barcoding and Research* Workshops, Beijing 166 School, DNALC

April 2-5	NSF NEON Diversity in Data Science Conference, "Broadening Participation in Data Science," NEON, Boulder, Colorado
April 6	NIH <i>Barcode Long Island</i> Open Lab, Brookhaven National Laboratory, Upton, New York NIH <i>Barcode Long Island</i> Open Lab, DNA Learning Center West <i>Urban Barcode Project</i> Open Lab, <i>Harlem DNA Lab</i>
April 10	"DNA Barcoding Research: The First Step in a Life of Science," Lecture, DNALC Asia, Suzhou, China
April 11	<i>Urban Barcode Project</i> Open Lab, <i>Harlem DNA Lab</i>
April 13	NIH <i>Barcode Long Island</i> Open Lab, Stony Brook University, Stony Brook, New York <i>Saturday DNA!</i> "WiSE Presents: Get to Know GMOs!" DNALC
April 16	<i>Urban Barcode Project</i> Open Lab, <i>Harlem DNA Lab</i>
April 17	NSF CyVerse Webinar Series, "Get Started with CyVerse," DNALC
April 22-26	<i>DNA Barcoding and Bioinformatics</i> Training Workshop, DNALC NYC at City Tech
April 24	NIH SciEd Conference, "Barcoding Long Island," Poster Session, Grand Hyatt Washington Hotel, Washington, D.C.
April 27	NIH <i>Barcode Long Island</i> Open Lab, DNALC
April 29	Regeneron Cultivation Event, Regeneron, Tarrytown, New York
April 30	<i>Urban Barcode Research Program</i> Update Event, The Irondale Center for Theater, Education, and Outreach, Brooklyn, New York
May 8	NIH <i>Barcode Long Island</i> Bioinformatics Open Lab, DNALC
May 9	Ötzi the Iceman Tour, DNALC
May 11	BioCodigo de Barras Symposium, "Proyectos de Investigacion Educativa a Traves de Biocodigos de Barras," National Institute of Genomic Medicine, Ciudad de Mexico, Mexico <i>Saturday DNA!</i> "April Showers Bring May Flowers," DNALC Ötzi the Iceman Tour, DNALC
May 15	City Tech Cultivation Event, DNALC NYC at City Tech
May 18-19	National Geographic Filming at DNALC
May 20	"The Slippery Slope of Eugenical Thinking," Cold Spring Harbor High School Science Symposium, Cold Spring Harbor, New York
May 21	Regeneron Cultivation Event, Regeneron, Tarrytown, New York
May 29	"Iceman - Ötzi's Final Days", Cinema Arts Centre, Huntington, New York
May 30	<i>Urban Barcode Project/Pinkerton Urban Barcode Research Program</i> Symposium, New York Academy of Medicine, New York, New York
May 30-31	NSF CyVerse <i>Genomics Data Carpentry</i> Workshop, University of Arizona, Tucson, Arizona
June 1	<i>Saturday DNA!</i> "Dust Away Crime: The Truth About Fingerprints," DNALC Ötzi the Iceman Tour, DNALC
June 4	<i>Barcode Long Island</i> Student Symposium, CSHL Introduction to Regeneron Event, Rye Country Day School, Rye, NY
June 7	St. David's School Science Expo, St. David's School New York, New York
June 8	Cold Spring Harbor Laboratory Open House, CSHL Ötzi the Iceman Tour, DNALC
June 10-14	<i>DNA Barcoding</i> for CURES Workshop, James Madison University, Madison, Wisconsin <i>Genome Science</i> Workshop, Lycee Francais, New York, New York <i>Green Genes</i> Workshop, Lycee Francais, New York, New York
June 11	Ötzi the Iceman Tour, DNALC
June 13	Ötzi the Iceman Tour, DNALC
June 13-July 3	<i>Biotechnology</i> Workshops, Grace Church High School, New York, New York
June 18	Ötzi the Iceman Tour, DNALC

- June 23-28 Gordon Research Conferences, Undergraduate Biology Education Research, Bates College, Lewiston, Maine
- June 24-28 *BioCoding* Workshop, Toms River High School East, Toms River, New Jersey
- June 25 5<sup>th</sup> Annual BOP Research Symposium, Governors Island, New York, New York
- June 30 CSHL Frontiers in Plant Science Workshop, "240 - Minute R Tutorial," CSHL
- July 1 HRPT Collaborator Training, Pier 84, Hudson River Park, New York, New York
- July 1-5 *Fun with DNA* Workshop, DNALC  
*Genome Science* Workshop, DNALC  
*Green Genes* Workshop, DNALC  
*World of Enzymes* Workshop, DNALC  
 Pinkerton *Urban Barcode Research Program* Conservation Genetics Workshop, *Harlem DNA Lab*
- July 8-12 *BioCoding* Workshop, DNALC  
*DNA Science* Workshop, DNALC  
*Forensic Detectives* Workshop, DNALC  
*Fun with DNA* Workshop, DNALC  
*World of Enzymes* Workshop, DNA Learning Center West  
*Fun with DNA* Workshop, Portledge School, Locust Valley, New York  
*World of Enzymes* Workshop, Toms River High School East, Toms River, New Jersey
- July 15-19 *DNA Barcoding* Workshop, DNALC  
*BioCoding* Workshop, DNALC  
*Green Genes* Workshop, DNALC  
*Fun with DNA/World of Enzymes* Workshops, Beijing 166, DNALC (2 sessions)  
 Pinkerton *Urban Barcode Research Program DNA Barcoding* and *Bioinformatics* Workshop, *Harlem DNA Lab*  
*DNA Science* Workshop, DNA Learning Center West  
*World of Enzymes* Workshop, Portledge School, Locust Valley, New York
- July 17 Ötzi the Iceman Tour, DNALC
- July 17-Aug 5 *DNA Barcoding* Workshop, DNALC Asia, Suzhou, China
- July 22 NSF CyVerse Webinar Series, "Get Started with CyVerse," DNALC
- July 22-23 "*DNA Barcoding: Uncovering Hidden Biodiversity in Your Own Back Yard*," K-12 Summer Institute, Kerrville, Texas
- July 22-26 *DNA Science* Workshop, DNALC  
*World of Enzymes* Workshop, DNALC  
*Forensic Detectives* Workshop, Beijing 166, DNALC  
*Green Genes* Workshop, Beijing 166, DNALC  
*Green Genes* Workshop, DNA Learning Center West  
 Pinkerton *Urban Barcode Research Program* Conservation Genetics Workshop, *Harlem DNA Lab*
- July 24 ISMB/ECCB Conference, "Overview of CyVerse Tools & Services: Intro to Data/Metadata Management," "Training, Technology, Togetherness - Promoting Knowledge Exchange in Life Sciences through Communities of Practice," Basel, Switzerland  
 Ötzi the Iceman Tour, DNALC
- July 26 "Cyberinfrastructure for Scaling Research, Education, and People," Lecture, Swizz Institute of Bioinformatics, Lausanne, Switzerland  
 Site visit by Emily Zeng and Xiaoli Wu, Shen Wai International School, Shenzhen, China
- July 29-Aug 2 *DNA Science* Workshop, DNALC  
*Fun with DNA* Workshop, DNALC  
*Forensic Detectives* Workshop, Beijing 166, DNALC  
*Green Genes* Workshop, Beijing 166, DNALC



- Fun with DNA Workshop, DNA Learning Center West*  
*Pinkerton Urban Barcode Research Program DNA Barcoding and Bioinformatics Workshop, Harlem DNA Lab*
- July 30-Aug 4 Invertebrates in Education & Conservation Conference, El Conquistador Hilton, Tucson, Arizona  
 July 31 Site Visit by Nan Gerson, Bethpage Federal Credit Union, Bethpage, New York  
 August 1 ASM Conference for Undergraduate Educators (ASMCUE), "Course-based Microbiome Research," Sheraton Tysons Hotel, Tysons, Virginia
- August 5-9 *Being Human Workshop, DNALC*  
*DNA Science Workshop, DNALC*  
*Green Genes Workshop, DNALC*  
*World of Enzymes Workshop, DNALC*  
*DNA Science Workshop, DNA Learning Center West*  
*DNA Science Workshop, DNALC NYC at City Tech*  
*Pinkerton Urban Barcode Research Program Conservation Genetics Workshop, Harlem DNA Lab*
- August 12-16 *DNA Barcoding Workshop, DNALC*  
*DNA Science Workshop, DNALC*  
*Fun with DNA Workshop, DNALC*  
*World of Enzymes Workshop, DNALC*  
*Forensic Detectives Workshop, DNA Learning Center West*  
*DNA Barcoding Workshop, DNALC NYC at City Tech*  
*Pinkerton Urban Barcode Research Program DNA Barcoding and Bioinformatics Workshop, Harlem DNA Lab*  
 NIH Barcode Long Island Teacher Workshop, Hyatt Place East End, Riverhead, New York
- August 14 Ötzi the Iceman Tour, DNALC  
 August 16 Site visit by Kim Libertini, Cold Spring Harbor Central School District, Cold Spring Harbor, New York  
 August 19-23 *Fun with DNA Workshop, DNALC*  
*Forensic Detectives Workshop, DNALC*  
*Genome Science Workshop, DNALC*  
*Green Genes Workshop, DNALC*  
*Fun with DNA Workshop, DNA Learning Center West*  
*Fun with DNA Workshop, DNALC NYC at City Tech*  
 STARS DNA Barcoding Workshop, CSHL  
*DNA Barcoding and Bioinformatics UBP Teacher Workshop, Harlem DNA Lab*
- August 26-30 *DNA Science Workshop, DNALC*  
*Fun with DNA Workshop, DNALC*  
*Green Genes Workshop, DNALC*  
*World of Enzymes Workshop, DNALC*  
 WiSE *Fun with DNA Workshop, CSHL*  
*World of Enzymes Workshop, DNA Learning Center West*  
 STARS *BioCoding Workshop, DNALC*
- August 28 Ötzi the Iceman Tour, DNALC  
 September 14 Pine Barrens Discovery Day, Wertheim National Wildlife Refuge, Shirley, New York  
 Sep 23-24 Regeneron Software Carpentry Workshop, "Reproducible Analysis in R," Regeneron, Tarrytown, New York  
 Sep 23-27 Week of Science Student Workshops, "Human Family," South Tyrol Museum, Bolzano, Italy  
 SUBMERGE Marine Science Festival, "DNA Barcoding for Biodiversity Research," Hudson River Park, New York, New York

- September 26 "Urban Barcode Research," Kickoff Event, The Irondale Center for Theater, Education, and Outreach, Brooklyn, New York
- October 5 *Saturday DNA!* "Agar Art," DNALC
- October 21 "DNA Restriction Analysis," Teacher Workshop, Math for America, New York, New York
- October 22 NSF CyVerse Webinar Series, "Get Started with CyVerse," DNALC
- October 23 Regeneron Training Session "Day of Doing Good," Regeneron, Tarrytown, New York  
Demystifying Science Reimagined at CSHL, "*DNA Barcoding: Infrastructure for Student and Citizen Science*," CSHL
- October 24 "Urban Barcode Research," Kickoff Event, The Irondale Center for Theater, Education, and Outreach, Brooklyn, New York
- October 25 Day of Doing Good Science Expo, "DNA Extraction from Wheat Germ," "Mutant Organisms," and "Diversity of Life," Regeneron Pharmaceuticals, Tarrytown, New York
- Oct 31-Nov 7 Site visit by Dr. Peter Bickerton, Earlham Trust, Norwich, UK
- November 1 Site visit by Michael Maturo, Frank Pusinelli, and David Garten, RXR Realty, LLC, Uniondale, New York
- November 2 *Saturday DNA!* "Making Sense of Your Senses," DNALC
- November 4 "DNA Restriction Analysis," Teacher Workshop, Math for America, New York, New York
- November 5 "DNA Restriction Analysis," and "Bacterial Transformation," Teacher Workshop, Regeneron, Tarrytown, New York
- November 15 NABT Conference, "The Last Days of Otzi," Sheraton Grand, Chicago, Illinois
- November 16 NABT Conference, "Biotechnology in American High Schools: Then and Now," Sheraton Grand, Chicago, Illinois
- November 18 "DNA Restriction Analysis," Teacher Workshop, Math for America, New York, New York
- November 18-22 NSF CyVerse *Train the Trainer* Workshop, Technical University of Graz, Graz, Austria
- November 21-22 Community College Undergraduate Experience Summit, "*DNA Barcoding: The CURE for Citizen Science*," Poster Session, Omni Shoreham Hotel, Washington, DC.
- December 3 Invited BD2k Seminar, "Computational Thinking, Learning, and Doing in 21<sup>st</sup> Century Biology," University of Puerto Rico, San Juan
- December 3-13 *Genome Science* Workshop, Beijing 166 School, DNALC
- December 4 Tech Night at Jack Abrams STEM Magnet School, Jack Abrams STEM Magnet School, Huntington Station, NY
- December 4-5 Cyverse Workshop, "Computational Tools and Reproducibility Workshop," University of Puerto Rico, San Juan
- December 6 Shelter Island Science Fair Judging, Shelter Island, New York
- December 7 "Biotechnology in American High Schools and Asian Models of DNALC Practice," Lecture, Shen Wai International School, Shenzhen, China  
NIH *Barcode Long Island* Open Lab, DNALC  
*Saturday DNA!* "DNA Detectives" DNALC  
Ötzi the Iceman Tour, DNALC
- December 8 "Biotechnology in American High Schools and Asian Models of DNALC Practice," Lecture, Tsinglan School, Dongguan, China
- December 9 "The Rules of Life: Thinking Like a Biologist," Lecture, SIP No. 2 Senior High School, Suzhou, China  
Site visit by Laura Slatkin, Nest Fragrances, New York, New York
- December 10 "The View from Nowhere in Computational Infrastructure," Lecture, University of Scotland, Dundee, UK
- December 12 Regeneron DNALC Launch Event, Regeneron, Tarrytown, New York
- December 14 *Urban Barcode Project* Open Lab, *Harlem DNA Lab*
- December 18 Site visit by Nancy Lippman and Carissa Jordan, CSHL Association Directors, Cold Spring Harbor, New York





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