Cold Spring Harbor Laboratory
DNA Learning Center

2021 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: DNALC staff worked with the Downtown Brooklyn Partnership to develop street banners to promote *DNALC NYC* at City Tech. Double-sided banners were placed in four locations around the neighborhood.

Executive Director's Report

ADMINISTRATION

Lauren Correri
Andréa Mahee
Valerie Meszaros
David Micklos
Donna Smith

INSTRUCTION

Kelsie Anson
Justin Burke
Megan Capobianco
Elna Carrasco
Kelly Eames
Arden Feil
Anna Feitzinger
Cristina Fernandez-Marco
Jennifer Hackett
Brittany Johnson
Jack Kellogg
Allison Mayle
Amanda McBrien
Bruce Nash
Sharon Pepenella
Jeffry Petracca
Xiaoqun Catherine Zhang

BIOMEDIA

Daniel Jacobs
Susan Lauter
Jason Williams
Chun-hua Yang

Carrying on with COVID-19

A year into the COVID-19 pandemic, the DNA Learning Center (DNALC) continued to find ways to be a hands-on science center "without hands." We converted all of our traditional lab field trips into virtual events, where students worked "live" with an online DNALC instructor, at home or in school. In the spring, we began to see a steady trickle of students coming for in-person instruction on school field trips, *Saturday DNA!,* and February winter break courses. To allow for socially-distanced instruction, we initially operated labs at ¼ capacity—with only one student per lab bench! This was part of an extensive "COVID-19 Safety Net" that included daily student temperature monitoring and health screening, and twice-weekly testing for DNALC instructional staff.

Hoping to capitalize on pent-up demand for hands-on science experiences, we rebooted our in-person science camps for the summer season. This required new Internet infrastructure to securely collect required vaccine records or negative COVID-19 tests, 50% occupancy to allow for social distancing, and vaccination of all DNALC staff. This allowed us to operate the entire summer without any reported COVID-19 cases. Camps held at our new Brooklyn facility and with partner schools helped us to compensate for smaller classes and accommodate 751 in-person campers—so attendance actually equaled pre–COVID-19 numbers of summer 2019. With an additional 102 virtual campers, supported with mail-order kits, the total summer attendance topped 2019 by 14%! However, income just equaled 2019 due to significant numbers of scholarships for minority/disadvantaged students (85) and Cold Spring Harbor Laboratory (CSHL) and City University of New York (CUNY) employees (17).

So, it was clear that students were anxious to get back into the lab for the hands-on experiences they missed during the pandemic. However, with the advent of the Omicron variant, late fall proved disastrous, with most Long Island school districts halting out-of-school activities and New York City (NYC) public students prohibited from using public transport for field trips. Our new facility at Regeneron Pharmaceuticals remained shuttered until late fall.

Top: During one of our first in-person programs since March of 2020, Amanda McBrien leads a *Green Genes* Camp presented over consecutive Saturdays. Bottom: Participants prep bacteria in an *Agar Art* spring break session.

The Long Road to Brooklyn

Postponed due to the pandemic, *DNALC NYC* officially opened on September 24th on the campus of the New York City College of Technology (City Tech) in downtown Brooklyn. With six teaching labs, two bioinformatics labs, exhibition, and lunchroom, the 17,500-square-foot facility is 25% larger than our flagship location in Cold Spring Harbor (CSH). At the opening ceremony, Bruce Stillman summarized CSHL's historical association with Brooklyn: "130 years ago, the Brooklyn Institute of Arts & Sciences established a teaching facility at Cold Spring Harbor. This Brooklyn initiative evolved over the years to be the global epicenter of modern biology and genetics. Through the DNA Learning Center program, the latest in life science is shared with students in real-life experiences and experiments. Today's event is a homecoming for Cold Spring Harbor Laboratory. We're thrilled to be back in Brooklyn and we hope to continue to make Brooklyn proud!"

Many people helped us along the way to Brooklyn, including three who are no longer with us—Mary Jeanne Harris, Wendy van Der Poel Russell, and Arthur Spiro. In the 1970's, Jim Watson said that he hoped for an angel who would help him save CSHL from bankruptcy; the DNALC's angel and constant friend has been Laurie Landeau (speaking, at left). In her remarks, Laurie recalled the many fits, starts, properties visited, and grants gained and lost on the road to Brooklyn. Her faith in our venture never waned, and she proposed that "patience" is a missing virtue in philanthropy.

In founding the *Harlem DNA Lab* we were lucky to have the support of NYC Schools Chancellor Joel Klein. In opening the Brooklyn center, we have had the support of many within the CUNY System—most notably City Tech President Russ Hotzler, who has become a fast friend in the process. At the ceremony, CUNY Chancellor Félix Rodriguez noted this long-term collaborative and looked forward to engaging large numbers of undergraduate students in research experiences.

When we had the idea to open a center in NYC, we looked at over a dozen properties in Manhattan in 2014–15—just as the market rebounded and they became unaffordable. Considering the possibilities of the Borough of Brooklyn was a real eye opener—because it was becoming clear to everyone that it was emblematic of the "new" New York. As Borough President, keynote speaker Eric Adams had been the primary architect of the tremendous revival of Brooklyn. In his remarks, he stressed the need for collaboration between government, education, and business to stimulate continued innovation in science and technology. True to this ideal, the Office of the Brooklyn Borough President provided $750,000 for state-of-the art scientific and exhibit equipment for *DNALC NYC* at City Tech.

Below, left: Russ Hotzler, Félix Rodriguez, Eric Adams, and Bruce Stillman.

Below, right: Speakers and other celebrants cut the ribbon commemorating the opening of *DNALC NYC*.

The long road to Brooklyn began in Cold Spring Harbor in 1985, when we developed simple methods to allow high school students to analyze DNA molecules. Long Island teachers were enthusiastic to learn this technology, so we came up with the idea of mobile vans full of equipment that could outfit any classroom for a gene cloning experiment. For a decade, we crisscrossed the country with two vans and trained thousands of teachers. In the meantime, in 1988, we started the DNALC at CSHL as the first science center devoted to public genetics education.

Over the next several decades we continued to develop lab and computer infrastructure that was used by hundreds of thousands of students per year. This supported the rapid growth of elective programs in biotechnology and student research. There are now convincing data showing that this approach works: students who have a significant research experience are 20 percent more likely to stay interested in science. They are also 20 percent more likely to graduate on time, which shows that thinking like a researcher has broad impacts on a person's life. We call this *Research Ready*—in doing research students are not only ready to compete in science, but they are also ready for further education and careers—ready for research, ready for life.

Wealthy schools realize this. Virtually all of the 124 school districts on Long Island and many in the New York metropolitan area have elective biotechnology and research courses—these schools accounted for 20% of 2020 finalists in the prestigious Regeneron Science Talent Search. We even started a Partnership Program to help private schools in Manhattan keep up with the suburban schools. Our National Science Foundation (NSF) supported study of 2,200 biology teachers in 2018 showed that 2/3 of high schools with biotech electives were in zip codes with household incomes above the US median. The best schools also infuse inquiry labs and project-based learning into regular science courses. Students from science-active schools are competitive for admission to the best science universities. They arrive at college ready to participate in early research opportunities that drive further success—including course-based undergraduate research experiences (CUREs) that reach many freshman students. They also learn skills and competencies that prepare them for the jobs of the future.

However, our own surveys of teachers showed that these great experiences were mostly only available in wealthy high schools. Students from resource-poor schools are not prepared to compete with their peers from schools with active biotech research programs for college admission and jobs—and in life. This is reflected in the persistent underrepresentation of Blacks, Hispanics, and Native Americans at all levels of science education and the workforce.

It was becoming obvious that the entire infrastructure we developed over several decades had failed to solve the hardest problem in science education: to involve a diverse population of students in real science. We realized we could never hope to solve this problem from Long Island; we needed to set up shop in NYC. So, in 2008, we teamed with the NYC Department of Education (DOE) to set up a single DNA lab in an NYC public school in Harlem. Our experiment in Harlem worked—there we found that we could readily reach a natural clientele that is about two-thirds disadvantaged and underrepresented minority students.

We then launched a decade-long search that led to *DNALC NYC*. It's the biggest physical infrastructure project we have tackled. Here, we will apply everything we have learned about science education over the last 35 years. Quite simply, we want to give to the students of NYC exactly the same practical and research experiences that Long Island students have enjoyed for decades.

DNALC NYC will bring *Research Ready* to level the biology playing field for URM and disadvantaged students through six major programs: 1) Broadly available enrichment for precollege students: field trips, summer camps, and intensive research experiences; 2) Virtual learning opportunities to reach more students in more situations; 3) Comprehensive college biology and life preparation; 4) Pathways to biology careers; 5) CUREs for CUNY students;

and 6) Public exhibition on shared inheritance and social justice. All these programs will help students to see themselves as people of science and to smoothly transition from high school to higher education and careers. This is especially important in NYC, where approximately two-thirds of public-school students are underrepresented minorities or from disadvantaged backgrounds and nearly 80% of freshman in the CUNY system are graduates of NYC public schools. In parallel with the renovation of the facility, we established an $11 million endowment to provide scholarships to at least half of all students attending academic year programs and to broadly support diversity, equity, and inclusion.

For the last 30 years, the DNALC has worked intensively with selected Long Island school districts and New York City Schools to develop strong, lab-based programs in modern biology. This begins with substantial genetics units in middle school, progresses to molecular genetics lab modules in Regents and Advanced Placement (AP) Biology courses, biotechnology electives, and culminates in capstone research programs in DNA sequencing. Through *Research Ready*, we will offer these same opportunities for under-resourced schools in New York City. First, we will work with school administrators and science teachers to develop a customized scope and sequence in biology, culminating in broadly available research experiences. Second, we will work with a selected group of motivated students to provide them a structured biology immersion over the last four years of high school—including summer and academic year courses and research experiences. Research mentors will guide these students and prepare them for college. An alumni network will support students, especially as they adjust in their college freshman year. College alumni will be welcomed back as peer mentors for subsequent years of the program.

What DNA Says About Our Past and Future

During the year, we made substantial progress on the permanent exhibition for the Brooklyn center, *What DNA Says About Our Past and Future*. Funded by a grant from CSHL Trustee Paul Taubman, the exhibit is the culmination of several decades of work to popularize "personal genetics" for students and to present a hopeful message of genetics in our lives. "DNA Past" will take a side door into issues of social justice by emphasizing that "knowledge of our shared genetic ancestry is the best inoculation against racism." The DNA of any two people is 99.9 % identical; racial and ethnic differences acquired as we peopled the globe are, indeed, only "skin deep." By exploiting current interest in ancestry, we want to make *DNALC NYC* a destination for people who want to incorporate DNA into their family exploration. During the year we reached an agreement with scientists from 23andMe to have exclusive access to their DNA data from hundreds of thousands of people. These data will be displayed on the centerpiece of the exhibit—a 9 x 16 foot "video wall" provided by a grant from the Office of the Brooklyn Borough President. A floor-to-ceiling world map will allow visitors to see personal DNA as data points in reconstructing migrations and diaspora that mixed people and their genes throughout history.

The weeks leading up to the September opening were a flurry of activity as the DNALC design team made ready the first component of our permanent exhibition, "Innovation and Gene Mixing in the Bronze Age." Two case studies—Ötzi the Iceman, from 3300 BC, and the early Philistines, from 1200 BC—examine how innovations in agriculture, animal husbandry, international trade, and metallurgy mixed genes in Eurasia. First, we retrieved a 3D recreation of Ötzi from his storage container in the CSHL warehouse in Syosset. He had languished there since his completion in 2017, with his twin currently on display at the DNALC in Cold Spring Harbor. The making of this replica from CT scan data was the subject of the PBS special, "Iceman Reborn."

Ötzi lived in the Alps at the very beginning of the Bronze Age and illustrates the transition between hunting-gathering and farming. Although he had the tools of a hunter, his DNA type originated in the Middle East—showing that he descended from early agriculturalists who

brought farming to Europe. In addition to presenting an ancient murder mystery, Ötzi illustrates the antiquity of supposedly modern maladies. DNA analysis revealed that he carried the genome of *Borrelia*, which causes Lyme disease. Although Ötzi ate a healthy "Neo(lithic)" diet, he carried DNA markers for heart disease and had Atherosclerotic plaques in his major artery.

The second part of the exhibit revolves around events in Ashkelon, Israel, at the end of the Bronze Age and into the ensuing Iron Age. The Leon Levy Foundation, an endowment fund contributor, introduced us to Daniel Master, of Wheaton College, and Adam Aja, of the Harvard Museum of the Ancient Near East. These archaeologists concluded 20 years of excavations at Ashkelon and uncovered the first Philistine cemetery. DNA analysis from graveyard skeletons validated oral tradition that the original Philistines were migrants from Minoan Crete. However, it also showed that the Philistines were genetically assimilated into the local Canaanite population within several hundred years of their arrival! Using 3D scans provided by Dr. Master, we worked with Blue Rhino Studios to recreate a Philistine burial from 900–750 BC. The authenticity of the display is heightened by eight pieces of Philistine pottery loaned from the Israel Antiquities Authority—shipped, and installed in time for the opening.

Perfume juglet from Ashkelon.

Adam Aja (top left) inspects artifacts from the Israel Antiquities Authority upon arrival at *DNALC NYC*. Dan Master (above, right) consults with Adam during installation of the objects. At left, staff unpack burial sculpture created by Blue Rhino Studio.It was all hands on deck prepping the *DNA Past* section of the exhibition prior to the ribbon cutting.

As the year ended, we began work with CSHL trustee Jeanne Moutoussamy-Ashe on a photo gallery that joins DNA past and future. "All the World in New York" will draw portraits from amateur photographers that highlight New York City as a modern melting pot—in the way the Middle East was during the Bronze Age. All people alive today are closely related by their common "DNA Past;" however, "DNA Future" points toward modern medicines that are tailored to the unique physical attributes of population groups and individuals. Among the DNA differences between any two people are mutations that make many diseases "personal." For example, similar cancers may be caused by different mutations in different people. Personalized, or precision, medicine tailors treatment to the specific mutations that drive disease in a particular person.

"New York Nobels" will highlight 35 Nobel laureates who graduated from NYC high schools and show what students visiting the DNALC can attain. A life-sized model of CSHL Nobel Laureate Barbara McClintock at work with her microscope is a hyper-local story of success in science—she grew up in Brooklyn and graduated from Erasmus Hall High School!

High School DNA Barcoding Research Programs

The DNALC continued to support authentic biodiversity research with high school students using DNA barcoding. *Barcode Long Island* (*BLI*), funded by the National Institutes of Health (NIH), involves students in "campaigns" 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 NYC. Science teachers are mentors for *BLI* and *UBP* students, while scientists from NYC institutions mentor *UBRP* students.

During the final year of funding through the NIH Science Education Partnership Award (SEPA), *BLI* supported 102 students in 34 teams. Despite the pandemic, 72 sequences were published in GenBank with student authors, including two new barcode records and 18 variants. Over seven years (see table), the program trained 234 Long Island teachers and supported nearly 1500 high school students, resulting in 654 GenBank published barcodes—providing important diversity and range information for over 200 species. Although NIH funding ended, schools continue their involvement by covering costs or through scholarships.

The SEPA project had important impacts on students who could be our next generation of scientists. Students (n=428) reported increased knowledge of the principles and process of DNA barcoding (90%), indicated they were proud of their research (85%), learned a lot about conducting science (89%), and felt the problem-solving skills they learned would help in future courses (84%) and careers (75%). Many also reported increased interest in further pursuit of STEM (50%) and, despite its difficulty, bioinformatics (46%).

Ninety-six students working on 33 teams completed projects in the *UBP* and 34 students working on 19 teams completed projects in the *UBRP*. With many schools, DNALC facilities, and mentor lab spaces unavailable, 11 *UBP* and seven *UBRP* teams used at-home DNA extraction kits to complete their projects with assistance from DNALC staff or mentors. Four *UBRP* teams presented posters to peers and science professionals at the annual Science Research Mentoring Program (SRMP) Virtual Colloquium in June.

Combined, during the year, 75 participants in the three high school barcoding programs completed project exit surveys. They were overwhelmingly proud of their research (90.9%) and valued the problem-solving approaches they learned (87.9%). More than three quarters said they were more interested in continuing to study science (77.6%) and biology (73.0%)—impressive in this group of students who already chose to do science research.

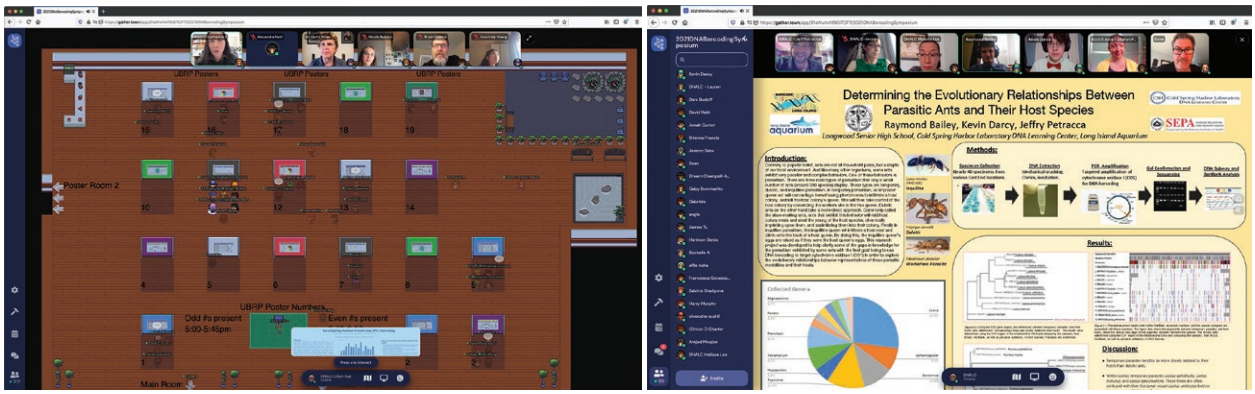
The annual research symposium was held virtually for the second time in 2021. *UBRP*, UBP, and *BLI* students presented their research together with *Barcoding US Ants* (discussed in next

Objective		*Barcode Long Island* Cohort Results							
		Cohort 1 2014–15	Cohort 2 2015–16	Cohort 3 2016–17	Cohort 4 2017–18	Cohort 5 2018–19	*Cohort 6 2019–20	*Cohort 7 2020–21	Total
Support 600 DNA barcoding research projects by 1800 high school students	Teams supported	29	91	106	133	79	45	34	517
	Student participants grades 9–12	78	271	312	382	208	124	102	1477
	Open Labs hosted by DNALC and collaborators	6	19	13	18	7	4	5	72
	Students attending Open Labs	13	171	122	190	73	35	27	631
	Reagent and equipment footlockers distributed	6	36	27	39	16	14	13	151
	Students supported by footlockers	36	282	271	325	114	39	94	1161
	Samples collected	580	1274	1257	1200	800	283	372	5766
	DNA sequence reads obtained	467	1580	1402	1917	1218	366	548	7498
Train and support 240 Teacher Mentors	Teachers trained	71	82	28	30	17	6	–	234
	Teachers mentoring student teams	22	31	33	44	22	10	14	176
Publish DNA barcodes to GenBank database	Previously unpublished (novel) DNA sequences	1	1	1	22	11	3	2	41
	Variant DNA sequences	–	–	–	34	52	41	18	145
	Sequences that provide species GPS information	4	1	–	95	139	177	52	468

**Cohorts affected by the pandemic*

section) participants on June 1st in a Gather Town space, allowing for both audio/visual and text-based interactions. Topics included wildlife across NYC and Long Island, biodiversity and trade, food fraud, and human health. Dr. Javier A. Izquierdo's (Hofstra University) keynote address on understanding, deconstructing and rebuilding microbiomes to make a better world was streamed through YouTube.

The barcoding research symposium featured a virtual poster session including presenter and attendee avatars that moved in the space and interacted via video in poster rooms.



Barcoding US Ants

The pilot cohort of *Barcoding US Ants*, our supplemental SEPA project that engages citizen scientists to identify and map ant species across the United States using DNA barcodes, wrapped up in January with a virtual mini-symposium. DNALC staff shared program results, including identification of 97 ant species from over 300 collected samples. Program entomologists Dr. Shawn Dash and Jeffry Petracca discussed how these specimens illustrate the gaps in knowledge of even familiar species and the importance of citizen science in presenting new data that can advance science. Participants from 13 of 26 teams shared their results and experiences during the symposium.

During the year, 274 GenBank records were published with citizen scientists as authors, which included 70 variable DNA sequences and 18 previously unpublished DNA sequences. Another 15 specimens could not be identified using a combination of DNA barcode sequence and morphology and are under further investigation. One hundred twenty-two staff from science and nature centers, members of conservation organizations, educators, students, and nature enthusiasts completed projects.

Following SEPA funding, 234 continuing or new participants investigate ant biodiversity through *Citizen DNA Barcode Network* (*CDBN*) or InnovATE*BIO*. Data analysis is ongoing.

Citizen DNA Barcode Network

This year, the *Citizen DNA Barcode Network*, our SEPA project following *BLI*, completed its first full year of programming. The project organizes local and national DNA barcoding campaigns for "citizen scientists" at science centers and conservation organizations. The aim is to engage the public by having them learn about and contribute to range maps of diverse ants, beetles, and mosquitoes. These include vectors of human disease, invasive species, and economically important species whose ranges are shifting due to climate change.

Our collaborators at the New York Hall of Science (NYSCI) helped design, pilot, and refine retractable banners to introduce the public to DNA barcoding, orient participants in roles as citizen scientists, and generate interest in upcoming events. NYSCI hosted *CDBN* events for the public and NYSCI interns. After training, collaborators at the Sweetbriar Nature Center (NY), the Long Island Aquarium (NY), the Cook Museum of Natural Science (AL), the HudsonAlpha Institute for Biotechnology (AL), and the Missoula Butterfly House and Insectarium (MT) also hosted public *CDBN* events. Activities included brief "tabletop" sessions introducing the use of DNA to identify species; partial- or full-day, hands-on labs; DNA barcoding training during internships; specimen collection events; and a multi-day DNA barcoding summer camp.

The first set of *CDBN* banners was shipped out in December to collaborators at the Long Island Science Center in Riverhead.

Despite limited facility access due to the pandemic and other natural disasters, the program supported over 1000 participants with a range of ages and skill levels. In total, 79 DNA barcodes were published to GenBank with citizen scientists as authors, including 22 previously unpublished barcode sequences and 24 new variants. Samples included a rare mosquito collected on Long Island (*Anopheles barberi*) whose larvae are generally sensitive to winter cold, and a click beetle (*Diplostethus texanus*) collected outside of its known range in Louisiana.

DNA Barcoding in Undergraduate Classes

We continued to develop, disseminate, and assess DNA barcoding and metabarcoding as "formatted" solutions for post-secondary course-based research experiences through our $2 million NSF IUSE collaboration with James Madison University (JMU), CUNY City Tech, Bowie State University (BSU), and Austin Community College (ACC).

We held a collection event for *CDBN* at Sweetbriar Nature Center in July where participants spent several hours learning sample collection techniques and gathering ant, beetle, and mosquito specimens.

In June, we held a virtual five-day *DNA Barcoding for CUREs* workshop for 22 faculty from seven four-year universities, nine community colleges, and two high schools. Meeting our goal of reaching a diverse audience, 23% of participants were Black and 5% were Hispanic/Latino. The workshop covered the methods and logistics needed to teach DNA barcoding CUREs and included presentations by participants from the previous year's workshop describing their implementations. Supplemental videos demonstrating biochemical steps ensured all participants could master the protocols. Fifteen participants completed these steps using materials supplied by the DNALC and submitted samples for sequencing, allowing them to analyze their results while learning the bioinformatics steps during the workshop.

We also held a virtual metabarcoding CURE workshop during the summer. The workshop included 41 educators from 25 four-year and 11 two-year colleges and universities, including 8% Black and 8% Hispanic/Latino participants. In June, sample collection methods, experimental design, and biochemistry were demonstrated, preparing participants to collect samples then isolate and amplify DNA. JMU supported participant sequencing using their MiniSeq for 270 samples. In late June, participants learned to analyze their microbiome data and began plans for implementing CUREs in the classroom. During the workshop, seven participants from the previous year shared their efforts, providing insights into how to successfully implement metabarcoding CUREs. Two CURE institutes were also held at BSU, introducing barcoding and metabarcoding CUREs to 42 faculty.

During the year, DNA barcoding was taught in 32 classes reaching 896 students, while 25 classes included metabarcoding—taught to 431 students. As with the high school DNA barcoding programs, participation in these CUREs had positive impacts: 64% of survey respondents felt they were capable of going further in science after the experience, while over half became more interested in technology, bioinformatics, and studying biology.

National Center for Biotechnology Education

The DNALC continued its work as a lead institution in the InnovATE*BIO* national biotechnology education center funded through NSF ATE, which supports training for America's workforce. Last year, we realized that Goal 4 of InnovATE*BIO* included a disparate set of activities that defied cohesion. This led to the concept of hubs to harness resident expertise and provide that expertise to the biotech community.

This year, we reorganized key InnovATE*BIO* activities into hubs as a means to enhance service to the community. The hubs support alumni and teachers; career options and entrepreneurship; high school to college pathways; workforce development; undergraduate research; supply chain models for training; and emerging technologies, including the hub we host, genomics, and a new immunotherapy hub.

In the fall, we added pages for each of the hubs to the center's website, aiming to position InnovATE*BIO* as a service organization that focuses on "What we can do for you." In this context, hubs function as national resources, as opposed to the traditional concept of regional resources. Structured interviews with community college biotech faculty members validated hubs as a useful way to organize InnovATE*BIO* activities. Given the positive feedback, design for an improved, search-optimized website began at the end of the year.

Through the Genomics hub, we continued to assist educators implementing genomics experiments and CUREs by supplying them with reagents, free sequencing, and technical or pedagogical support. We also supported development of a Sanger Sequencing Service at Liberal Arts and Science Academy (LASA) High School, Austin, funded by an ATE grant to Joseph Oleniczak (LASA and ACC) and Kissau Tchedre (ACC). Students from LASA's dual-credit

biotechnology program perform DNA sequencing as a service, including for students at ACC, who visit the high school to learn Sanger sequencing.

Accessible Biomanufacturing to Teach Biotech Skills

In parallel to our work as part of InnovATE*BIO*, we started a new project to popularize the free isolation of *Taq* polymerase for classroom use in collaboration with Aron Kamajaya of Los Angeles Pierce College. Supporting the Center's supply chain hub, this ATE project is developing a biomanufacturing curriculum on the manufacture of *Taq* polymerase. We optimized simple isolation protocols to increase yield and constructed a new plasmid, p*SimpleTaq*, allowing constitutive expression of *Taq*, and removing the complexity and expense of induction. Expressing, purifying, and assaying *Taq* polymerase will familiarize students with all aspects of product manufacturing and quality control. Providing a free product to high school "consumers" will make polymerase chain reaction accessible to many more students.

In late fall, Dr. Kamajaya piloted *Taq* isolation with 12 Pierce College Biotech interns at the Pasadena Bio Collaborative Incubator. The interns prepared enough *Taq* extract to support 10,000 PCR reactions, and then developed PCR protocols for use by students in a microbiology course in the coming term.

NSF CyVerse

Although online training was the only option for faculty and students in 2020, constant disruptions and uncertainties made the pivot to virtual less than seamless. After plummeting more than 40% last year, *DNA Subway* usage rebounded in 2021 with all-time peaks of 48,035 registered users (12% increase), 1.18 million page views (29% increase from 2019), and 38,059 student projects (28% increase from 2020).

In addition to analyses on *DNA Subway* lines, we created new teaching resources for the command line. Working with long-time collaborator and DNALC workshop attendee Ray Enke from JMU, we published *A Fun Introductory Command Line Lesson: Next Generation Sequencing Quality Analysis with Emoji!*[1] in CourseSource, an online journal for biology and physics teaching. This lesson uses an application we developed on CyVerse to walk students through a quality control exercise analyzing next-generation DNA sequencing reads. Each DNA base sequenced is assigned a Phred score that indicates the probability it has been incorrectly called. A low score (e.g., 10) indicates a 1 in 10 chance of being wrong, and a high score (e.g., 40) indicates a 1 in 10,000 chance of being wrong—99.99% accurate. This fun lesson was developed as a *Jupyter Notebook* within the newly updated CyVerse *Discovery Environment*, allowing students to learn command line computing while working with real sequence data. Several of these notebooks and tools were also used by students in this year's new *Sequence a Genome!* camp.

Finally, we continued our advanced training to cohorts of 130 graduate students, postdocs, and faculty in two 10-week online cohorts in our *Foundational Open Science Skills* course. We also reached another 363 faculty and students at various online training events and seminars including the International Society for Applied Microbiology Conference, North Carolina State Undergraduate Research Experience, James Madison University Center for Genome & Metagenome Studies workshop, and the NIH National Human Genomics Research Institute Short Course in Genomics.

1. St. Jacques, R. M., Maza, W. M., Robertson, S. D., Lonsdale, A., Murray, C. S., Williams, J. J., & Enke, R. A. (2021). A Fun Introductory Command Line Lesson: Next Generation Sequencing Quality Analysis with Emoji! CourseSource, 8. https://doi.org/10.24918/cs.2021.17

Licensed Centers

With the continued closure of Regeneron's Sleepy Hollow campus, field trips and summer camps in the Westchester area remained virtual for the majority of the year. After an extensive fall email campaign and several Open House events to reignite awareness of the new *Regeneron DNALC*, we hosted 260 students for in-person field trips. We also participated in a Virtual K-12 STEM Teacher Conference sponsored by Mercy College Center for STEM Education, where teachers were invited to learn more about DNALC programs in a virtual exhibition hall.

Campus restrictions prohibited the Notre Dame DNALC from conducting any in-person events through September. In summer, camps were offered virtually for 20 participants with materials kits shipped to students' homes, and processing of returned student samples handled onsite by staff. In-person programs resumed in the fall with 150 participants who attended an event at a Football Saturday, and a limited number of field trips.

International Partnerships

China

Due to restricted international travel and leadership changes at Beijing No. 166 School in China, our collaboration was put on pause. Over the past three years, *Barcode Beijing* program students published 130 DNA sequences to GenBank, which included 122 species, and 23 new variants. We think this noteworthy accomplishment—made by a single secondary school in China—may encourage more schools in China to engage in our brand of hands-on science.

In an effort to support science education for international students during the pandemic, we launched *Mentored On-Demand Camps*. These camps are a combination of our *Live Virtual* camps (taught live, but remote) and *On-Demand* camps (pre-recorded instructional videos). In the hybrid camps, instruction is primarily through pre-recorded videos, but several in-person sessions with DNALC educators are built into the schedule to provide time for Q & A, troubleshooting, and engagement with an instructor. This summer, 16 students from Keystone Academy, Shenzhen International School, and Guangdong International School participated in *Fun with DNA* and *DNA Barcoding Mentored On-Demand Camps*. Three teachers from Keystone Academy, a private school in Beijing, were trained to teach the camps using our pre-recorded instructional videos and individually packed materials kits. Kit preparation and distribution was coordinated by *DNALC Asia* in Suzhou. One of the participating teachers reported, "The students were quite happy with the program and we were able to complete all experiments and activities."

We also began to advertise International Partner Membership modeled after our successful partnerships with independent schools in the New York metro area. Four international schools—Beijing No. 5 School, Shuangliu School, Keystone Academy, and Tsinglan School—have expressed interest. When travel restrictions are lifted, we will be able to send instructors to International Partner schools and host their students in New York for camps.

Despite the challenges of the pandemic, *DNALC Nigeria* is now renovated and operating. Michael Okoro runs day-to-day operations and is supported by three teaching assistants and undergraduate interns who help deliver instruction.

More than 250 students and visitors attended workshops and research programs, including undergraduate courses and school visits. In January, the center hosted a metabarcoding workshop for students from Godfrey Okoye University, *DNALC Nigeria's* host institution. The group sampled microbial soil from lakes on the Ugwuomu campus. A second cohort in March included postgraduate students and faculty from other Nigerian institutions. Through a grant from the US Consulate in Lagos, a series of DNA barcoding workshops kicked off in August. This program will ultimately reach 160 high school students and 40 teachers from

Michael Okoro (right) and program participants at *DNALC Nigeria* (below).

Enugu State by its completion in March 2022. The center also participated in the DNALC *Barcoding US Ants* project and collected DNA from approximately 170 ant species in urban and rural parts of Southern Nigeria. Through a grant from the British Council, *DNALC Nigeria* participates in the *Innovation for African Universities* program, which supports the creation of STEM business and entrepreneurship through student training.

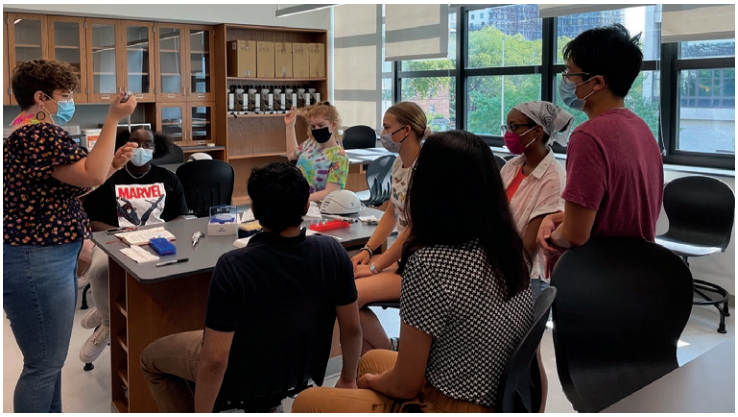
Dissemination at Professional Meetings

As in previous years, we continued to disseminate our programs at meetings. DNALC staff presented DNA barcoding and metabarcoding at the CSHL Genome Informatics Conference and NIH SEPA SciEd Conference. Our data science programs were also presented at the International Applied Microbiology Conference, while our analysis of American Science Education was presented at Cell Bio Virtual 2021, an American Society for Cell Biology/ European Molecular Biology Organization meeting.

Lab Instruction and Outreach

Mid-pandemic, 2021 programs began with a complete shift to virtual instruction. As schools struggled to adjust to schedule changes, staggered cohort instruction, and restrictive health and safety guidelines, in-person field trips and school visits were not permitted. We provided remote field trip experiences to 10,179 students through demonstrations and kit-based experiments.

In lieu of school field trips, we were able to begin providing safe, on-site instruction in winter—a nice change of pace for students who were limited to remote instruction at school. Sixteen students attended AP Biology prep courses on Saturdays to complete a series of labs that either are required by the College Board, or include techniques and concepts that are integral to the curriculum. Five other students attended a Saturday *Green Genes* series—one of the summer camps that could not be taught virtually. One hundred and ninety middle and high school students opted to forgo their winter and spring breaks to participate in a series



DNALC NYC held its inaugural summer of camps, welcoming students in 20 camps. (Above and right)

The STARS camp returned to in-person instruction for its third year. Dr. Lloyd Trotman and Dr. David Jackson spoke to the students about their research during the two-week program.

Returning to in-person summer camps came with curb-side check-in and temperature checks, an enormous tent to accommodate socially-distanced lunches, reduced-capacity classrooms, and virtual parent days for middle school camps.

of fun and engaging daily lab sessions on topics including: DNA structure and function, industrial enzymology, genetic engineering, forensics, and GMOs.

September brought less restrictive distancing requirements and an optimistic return to in-person instruction. A total of 3,135 students attended in-person lab field trips at our four facilities: Dolan DNA Learning Center, *Harlem DNA Lab*, *Regeneron DNALC*, and *DNALC NYC* at City Tech. In-school programs reached 1,789 students. Footlocker kits were used by 440 students, 64% of whom were conducting independent research through *BLI*, *UBP*, and *UBRP*.

Field trip scholarships were provided for 174 students from Uniondale School District, Ossining School District, Danbury School District in Connecticut, Kearsarge School District in New Hampshire, Passaic Academy of Science and Engineering, and Jack and Jill of Central New Jersey. An additional 326 sixth grade students from Central Islip School District participated in a kit-based series of virtual labs supported by a grant from the National Grid Foundation. This year, 292 (12%) of the students who attended in-person field trips and virtual programs at the *Harlem DNA Lab* and *DNALC NYC* at City Tech came from Title I schools that qualified for tuition assistance supported by the William Townsend Porter Foundation.

In summer, we returned to in-person camps at the Dolan and NYC locations. With COVID-19 guidelines that included fully-vaccinated instructors, distanced workstations, individual equipment, and daily health screening, we hosted 542 campers on Long Island, and 218 in NYC. We provided scholarships for 88 students. Another 26 campers participated in off-site workshops at Francis Lewis High School in Queens and Friends Academy in Locust Valley. One hundred and seventy two students attended *Virtual Live* or *On-Demand* camps, including 48 middle schoolers who attended through City Tech's *Bridging the Gap*, a Science and Technology Entry Program (STEP) for pre-college students.

Now in its third year, the Science, Technology, and Research Scholars (STARS) program has become a community of young researchers from groups that have been traditionally underrepresented in STEM. This year we accepted 15 students from nine districts across Long Island and New York City for a two-week course in Cold Spring Harbor. Thanks to a donation from CSHL Trustee Laurie Landeau, half of our students benefitted from bussing provided by Suffolk Transportation. To kick things off, students and their families joined us for a Saturday afternoon orientation featuring STARS alumni joining via Zoom to present their summer research experiences.

This year Harrison Banks (2020) had a summer internship in Robert Martienssen's Laboratory, and Diana Benedicto-Jimenez (2019) worked in Chris Vakoc's lab as part of the CSHL Partners for the Future Program. STARS students also made their own contributions to the roll out of the COVID-19 vaccination effort. Students created more than three dozen videos—posted to YouTube and the DNALC website—on the science behind COVID-19 and historical healthcare inequities in minority communities. We also completed an assessment of the impact of STARS on the first two student cohorts. One hundred percent agreed that STARS helped

them prepare for a future research experience, 94% agreed that they felt mentored by STARS instructors, and 87% agreed that STARS helped them set goals for their careers. Importantly, 84% agreed that STARS helped them find role models with whom they identified, and 83% reported doing some activity that follows up on their interest in STEM—including high school research internships, undergraduate STEM majors and research internships.

Jason Williams prepares Duckweed samples during the *Sequence a Genome* camp.

A new summer camp, *Sequence a Genome!*, brought students "into the genome age" by allowing them to fully sequence a genome using Oxford Nanopore DNA sequencing. In Nanopore sequencing, DNA is drawn through pores embedded in a membrane, generating an electrical signal that is reconstructed into DNA sequence. A single, handheld Nanopore device can generate billions of base pairs of DNA sequence in hours for about $1000. We chose to sequence a strain of Duckweed, *S. polyrhiza*, which has a relatively small 150 million base pair genome. This plant, commonly seen growing on ponds, is being studied by the CSHL Martienssen laboratory as a candidate for biofuel production and carbon sequestration. Guest lectures included Sara Goodwin from the CSHL Genome Center and Alex Harkess from the HudsonAlpha Institute for Biotechnology, who has sequenced other Duckweed strains. Students extracted DNA that was used to generate more than seven billion base pairs of sequence, and went on to do bioinformatics needed to analyze the data. Several continued to meet virtually in the fall to work towards completion of an entire assembly.

In partnership with CSHL Women in Science and Engineering (WiSE), we hosted the fifth annual *WiSE Fun with DNA* summer camp. Ten young female science enthusiasts had the opportunity to meet and interact with engaging role models pursuing careers in the sciences. Each afternoon, the girls participated in WiSE activities on cancer research, neuroscience, and gene expression. On the final day of camp, parents and campers were invited for a guided tour of the main CSHL campus, and an outdoor lab activity.

The *Partner Member* program continued to provide custom instructional sequences and advanced electives for six independent schools in New York City, including kit-based virtual instruction in spring for a fully remote hands-on experience.

- Research teams from Fontbonne Hall Academy used DNA barcoding to produce novel GenBank entries for flowering plants and snails. AP Biology students studied viruses, vaccines, and protein structure, and created 3D-printed models of the SARS-CoV-2 spike protein.
- At Marymount School of New York, genetics programs were incorporated as key parts of the biology curriculum at multiple grade levels. Students in Independent Student Research tested Loop-Mediated Isothermal Amplification (LAMP) PCR of the human PV92 Alu locus as a method for at-home PCR that doesn't require a thermal cycler.
- Sacred Heart Greenwich adopted a quarter membership with implementation of a DNA barcoding unit for its Science Research students.
- Lycée Français de New York implemented genetics programs in their AP Biology courses.
- The Chapin School coordinated genetics programs at several grade levels, including the advanced Molecular Genetics elective. Middle school students analyzed PCR product sizes from a mock locus to genotype a hypothetical family when studying a genetic disease.

- St. David's School integrated basic genetics with existing curricula in grade five. Grade eight used DNA barcoding to survey the ants of Central Park.

With the success of the *Partner Member* program in New York City we updated our school membership programs to include three different options. *Sustaining Members* receive field trips, advance registration, priority reservations for teacher workshops and special events and opportunities to audit summer camps. *Associate Members* receive all the *Sustaining* benefits, with an additional ten days of customized instructional time for project-based research, research mentorship, enrichment of existing curricula, or focused faculty training. Finally, *Partner Membership*—for local and international schools—includes 20 days of customized instructional time that can include developing and co-teaching advanced electives, access to emerging DNALC projects that incorporate cutting-edge techniques, and weeklong camps during school breaks. This year we were thrilled to add two new *Partner Members* from Long Island—Massapequa School District and Long Beach City School District—schools that have maintained sustaining membership for many years, and want to strengthen their science brand through increased exposure and opportunity. Glen Cove City School District, a first time DNALC member, joined as an *Associate Member* with the same goals.

As part of other ongoing local partnerships, the *Molecular and Genomic Biology* elective returned to Cold Spring Harbor High School after a pandemic hiatus. The 12 enrolled students spent the last two periods of every other school day at the DNALC, immersed in hands on experiments in DNA barcoding, human and plant genomics, bacterial genetics and gene cloning and bioinformatics. Similarly, 13 students from St. Dominic High School in Oyster Bay participated in a half-year *Molecular and Genomic Research* elective taught at the DNALC. As part of their course requirements, all students in both classes participated in *Barcode Long Island*.

Our Ötzi the Iceman exhibition had 100 in-person visitors, and 870 attended virtual museum tours guided by educators remotely, while the *DNALC Live* pre-recorded Ötzi museum tour on YouTube had a whopping 1,755,340 views in the year! Nineteen *Saturday DNA!* sessions, both virtual and in-person, drew 200 participants. Virtually, participants used kits to extract DNA from strawberries and build their own gel electrophoresis chambers. They also explored how population size contributes to genetic drift and how our ancient ancestors contributed to modern human genetics. In-person participants learned about Mendel's laws of heredity, created works of art inspired by our beautiful Joe Rossano BOLD exhibition, and unraveled some forensic mysteries surrounding Ötzi the Iceman.

The "Meet a Scientist" remote lecture series continued to connect high school and public audiences with CSHL researchers, drawing 90 participants. Guest presenters shared their research, and stories of their journeys to becoming scientists. Dr. Lloyd Trotman presented his work on cancer metastasis and 3D analysis; Ph.D. student Miriam Ferrer Gonzalez talked to us about the whole-body response to cancer; graduate student Alexa Pagliaro delivered a talk on how maternal experience shapes brain activity; Dr. Hannah Mayer shared her work on how T-cells distinguish friend from foe in our immune systems; Dr. Peter Koo introduced his research understanding gene regulation through deep learning; Dr. Doreen Ware presented her research on maize and how plants manage fluid genomes to adapt and evolve; and Dr. Christopher Vakoc talked about inventing new cancer medicines. All of the presentations are available on the DNALC website.

This year our collaboration with the CSHL School of Biological Sciences was put on hold. As part of their required curriculum, first-year graduate students usually work with DNALC instructors to develop skills needed to communicate science to a variety of audiences. Students complete 12 half-day sessions in which they progress from observation to co-instruction, and then independent teaching of lab classes. The 2021 cohort will participate in training in 2022.

BioMedia Visitation and Projects

In 2021, 7.68 million visitors accessed our suite of multimedia resources, a 144% increase from the previous year! This rise is attributed to another stunning increase in visitation to our YouTube channel, which received 4,633,125 views—274.7% over 2020! Watch time increased to 505,648 hours (627%) and we added 22,721 (170%) new subscribers. Two videos recorded early in the pandemic went viral:

- "Museum Tour: Ötzi the Iceman" (1.8+ million lifetime views) presented by Amanda McBrien; and
- "What DNA Says About Our Human Family Episode II, Ancient Relatives: Neanderthals and Denisovans" (874+ thousand lifetime views) presented by Dave Micklos.

Google Analytics counted 2.6 million visits to DNALC websites, 84.6% of the prior year. With the end of support for Adobe Flash in all browsers at the end of 2020, we faced losing several of our content-based websites that were built using this technology. Fortunately, we were able to implement Ruffle, a Flash emulator that could be incorporated on some sites, including *Inside Cancer*, *Your Genes, Your Health*, and *DNA Interactive*. Some sites have been redirected to older non-Flash versions, such as the Eugenics Archive and Weed to Wonder. Unfortunately, *Genes to Cognition* and *Lab Center* are completely dependent on Flash and could not be revived. However, much of the content from these sites is available in alternative formats through our homepage's media search.

In 2021, 439,672 *3D Brain* and *Gene Screen* smartphone/tablet apps were downloaded. The ten-year-old *Weed to Wonder* E-book for iPads has been removed from the Apple App Store since the software used to develop it can no longer be used to update the app.

With the opening of *DNALC NYC* and the distance at-home instruction placed between teachers and students, the time was right to revamp how we reach parents and students with our summer camps. We decided to work with a digital marketing company, WebFX, to develop a new online strategy. This included search engine optimization (SEO), which makes our website more "visible" to search engines by improving our ranking as an authoritative source and by optimizing for search terms people used to find us. WebFX has given us insight into how ranking factors used by Google (e.g., page authority, domain authority) can be improved to increase site traffic. In addition to SEO, WebFX has significantly enhanced our ability to reach parents directly through Google Ads and Facebook. Since 2016, we have tracked new summer camp participants by asking, "How did you learn about DNA Learning Center camps?" Traditionally, only about 3% of new summer camp parents find out about us through internet ads and search. Our marketing efforts increased that to 22% this year. We also benefitted from an ongoing nonprofit Google Ads grant which generated 117,291 impressions and 12,349 clicks—the equivalent $19,546 in advertisement spending.

Staff and Interns

Congratulations are in order for DNALC staff! In April, DNALC Assistant Director Amanda McBrien was recognized by Crain's New York Business 2021 list of Notables in Nonprofits and Philanthropy. This year's list was "in celebration of 57 New York heroes who facilitated or led nonprofit work in the face of the pandemic."

Our Executive Director Dave Micklos was named the winner of the 2021 Bruce Alberts Award for Excellence in Science Education by the American Society for Cell Biology. This prestigious award recognizes career-spanning achievements in biology education.

The opening of *DNALC NYC* at City Tech brought new staff to Brooklyn, and the Dolan DNALC also saw some staff changes.

As mentioned on pages 4-5, *BioMedia* staff readied the *DNALC NYC* exhibiton space in time for the September ribbon cutting. This included temporary table displays for Otzi artifact replicas and a simple base for the mummy replica while its glass display case was delayed due to supply chain issues. Temporary labels were also hung.

Arden Feil started in June. She has both a Bachelor's and Master's degree in Biology from Wesleyan University. Her research focused on how chromosomes interact and exchange genetic information during meiotic cell division. She also majored in Science in Society, which taught her to consider the cultural, social, and political significance of her science training. This combination cemented her interest in making science accessible and relatable to everyone. She participated in science outreach efforts, from mentoring students to teaching afterschool programs and summer camps in NYC. After graduating, she worked as a Research Specialist at the University of Chicago in a lab that studies a cell signaling in tissue development. She realized that, although she loved the inquiry-driven, dynamic nature of lab work, she missed her favorite part of science—getting to share it with other people! Now, as an educator at *DNALC NYC*, she is excited to combine her research and teaching backgrounds to facilitate engaging learning experiences.

Top: Arden Feil, Andrea Mahee, Kelsie Anson, and Donna Smith. Bottom: Anna Feitzinger, Kelly Eames, and Jack Kellogg.

Andréa Mahee came aboard in June, as the *DNALC NYC* Administrative Manager. She brought to the table a myriad of skills including C-suite support; curating and managing special events; conducting workshops, meetings, and trainings; and is multilingual in French, Spanish, and Italian. She spent many years in the development arena; she was Chief of Staff at the Third Avenue Business Improvement District, executive assistant at the Bronx Council on the Arts, and development associate for the South Bronx Overall Economic Development Corporation.

In July, Kelsie Anson joined the Brooklyn team. Hailing from rural Wyoming, it was family trips to Yellowstone National Park that ignited her interest in science. She had a special interest in the thermophilic bacteria that lived in the hot springs in the park—where one of our important DNA engineering molecules, *Taq* polymerase comes from! She earned a degree in molecular biology from Colgate University, where her senior research project explored how genetics might dictate social behavior in an ant colony. After graduation, she worked as an analytical chemist for an environmental testing company then later took a research position at Rocky Mountain Laboratories in Montana, studying prion diseases—deadly brain diseases most common in elk herds in the Western US and Canada. In 2020, she was awarded her Ph.D. in biochemistry from the University of Colorado in Boulder. Her research used fluorescent sensors to measure fluctuations of zinc ions and determine the role these ions played in crucial cell signaling pathways. She also created an interactive teaching case study where undergraduates learned how to genetically engineer bacteria to break down environmental toxins. Kelsie also tutored middle schoolers on optical physics and occasionally starred on the college podcast, *Buffs Talk Science*.

In July, the DNALC welcomed Donna Smith to the administrative staff. A graduate of Harborfields High School, Donna received her Bachelor's Degree in History from Moravian University, previously known as Moravian College, in Bethlehem, Pennsylvania. Donna worked for 12 years at Akorn Pharmaceuticals as a Lab Clerk in the Quality Control Raw Materials Lab, working on file management for new drug submissions to the FDA; sample intake for in-house testing; contract lab sample submissions for outside testing; and requisition creation for

chemicals, standards, lab, and office supplies. Her duties at the DNALC include scheduling lab visits to the *Regeneron DNALC*, statistical record keeping, ordering office supplies, answering phones, and greeting visitors and students.

Anna Feitzinger started at *DNALC NYC* in August. After graduating with a degree in Chemistry from Hunter College, she worked as a research associate at the Skirball Institute at New York University in the developmental genetics department—gravitating to developmental and molecular biology. She never tired of imaging a glowing population of cells migrating across a live developing zebrafish embryo. It was this experience which prompted Anna to pursue a Ph.D. at the University of California, Davis, where she joined an evolution of development lab in the evolution and ecology department. Her interests in quantitative and developmental biology were united as she worked on characterizing the natural variation of gene expression of early stage fruit fly embryos. While at UC Davis, she also worked as a teacher's assistant for a genetics and molecular biology lab course. It gave her great joy to communicate science and guide students during their first DNA extractions, gel electrophoresis, cloning, and fruit fly crosses.

Kelly Eames joined the Dolan staff as an educator in August. She has her parents to thank for encouraging her scientific endeavors and introducing her to genetics and microbiology—and more importantly to the DNALC. As an alum of our summer camps and *Saturday DNA!* programs, Kelly applied skills learned at the DNALC in her college courses. In 2013, she earned a bachelor's degree in biology and chemistry at Molloy College, then pursued a master's degree at Trinity College in Dublin, Ireland. The program focused on biodiversity and wildlife conservation; her thesis examined the different educational methods used to teach visitors to zoos and aquaria about conservation and community action. Engaging guests in interactive learning exercises was shown to better their understanding, especially when compared to passive learning (such as reading or videos). Now, ten years after her last DNALC camp, Kelly works alongside some of the people who introduced her to these topics in high school. She is excited to offer the same opportunities to students today.

In November, Jack Kellogg joined the staff in preparation for reopening our Regeneron site. Growing up on farmland in a small rural town outside of Buffalo, NY, Jack loved exploring the woods and learning about the varied species of trees on their property. These explorations coupled with watching every episode of the nature docuseries, *Planet Earth*, sparked his fascination with the different behaviors, life histories, and morphologies of organisms. He attended Rutgers College, Newark, majoring in Biology. He had the privilege to join an insect evolution lab led by Dr. Jessica Ware. As an undergrad, he used computer vision to examine wing color patterns in tropical butterflies and investigated the effect major weather events have on dragonfly dispersal in New Jersey. He traveled to the Amazon as part of a field course focused on different methods in entomological research, including tree canopy surveys and bait traps. He and his group also did a small study related to butterfly mimicry. For his master's thesis, he used DNA barcoding to study the population genetics of aquatic insect communities.

We say goodbye to a number of our staff who have moved on in 2021: from our administrative department, Mary Lamont and Colette Riccardi; educators Melissa Lee, Louise Bodt, and Lina Ruiz-Grajales; and senior programmer Cornel Ghiban.

In 2003, Mary Lamont began as an Administrative Assistant for DNALC *West*, located within a Northwell Health facility in Lake Success. In an office no bigger than a closet, she quickly rose to Administrative Manager and Manager of Offsite Programs. DNALC *West* field trips included a tour of the core blood-testing facility, often led by Mary. With proficient politeness, a "no-nonsense" attitude, and outstanding communication, she built excellent relationships with visiting schools and teachers and did a wonderful job supporting instruction at *West*. When not at the DNALC, she is a traveling country singer with her husband. After 18 years of loyalty and dedication, Mary retired to continue singing and enjoy being a grandmother.

Colette Riccardi joined the administrative staff as our receptionist in March 2018. Her duties included answering phones and greeting guests at the DNALC, ordering all office supplies and arranging repairs for office equipment, and entering and organizing data. As an "Excel champion," she tackled complicated projects with ease. Her work ethic, dependability, and lovely personality also gave her an advantage when interacting with the public and forging relationships for the DNALC. Pregnant with her little boy, Leo (who was born in May), she decided to switch careers to full-time mom in February.

Harlem DNA Lab Manager Melissa Lee joined the DNALC family in 2011. She used her background in science education and lab management to deliver hands-on labs to thousands of students. Melissa managed the *Harlem DNA Lab*, taught high school and middle school classes, managed interns, and ran the footlocker equipment rental program. She also played a large role in the set-up and management of the *Regeneron DNALC*. She directed NYC teacher training and worked with many of our partner schools. Melissa assisted in grant writing and in the execution of those grants, and she mentored students for symposiums and competitions. With a passion for outreach and research, she became immersed in *UBP* and *UBRP*. Through her tenure at the DNALC, she ardently and continuously promoted our mission across NYC. In June, she decided to put her smart board markers away to become a full-time mom to her one-year old son, Alex. We will miss her exuberant personality, her fine leadership skills, and her infectious enthusiasm.

Louise Bodt, a Brooklyn native, began her DNALC journey in August 2019 as an educator and *UBP* manager based out of our City Tech temporary lab. In addition to the instruction of high school and middle school students, she helped train and supervise interns in Brooklyn. She was the relationship manager for one of our partner schools, the Fontbonne Hall Academy for Girls in Brooklyn, as well as a *UBP* program manager. Louise also participated in grant writing for the *UBP*. At the onset of the pandemic, she helped to develop and promote virtual classes. Although she left the DNALC before the opening of *DNALC NYC*, she played a large role in promotion and outreach. She left in June to pursue her Ph.D. in Evolutionary Biology in the graduate program at the University of Chicago.

Lina Ruiz-Grajales joined the DNALC in November 2019 as an instructor for *Regeneron DNALC*, which had its grand opening that December. In addition to teaching high school and middle school, her strong research background allowed her to shoulder much of the lab preparation needed at our brand-new facility. When the facility closed temporarily in March of 2020, Lina shifted her focus to the development of virtual lessons and protocols. She also participated in developing protocols and laboratory techniques for *Barcoding US Ants*. Lina left in August to pursue her Ph.D. in Biological Sciences at Columbia University.

Cornel Ghiban, our computer programmer, began his odyssey at the DNALC in late 2006. Prior to arrival from his home country of Romania, he did contract work for us developing the "back-end" of our websites. He became the DNALC's "nervous system"; Cornel designed, updated, and maintained several tools used to engage students and researchers in biotechnology. He played a large role in creating and supporting new features for *DNA Subway* (maintaining the Blue Line databases and QIIME, adding new and updating old transcriptomes for the green line when necessary and making other changes as requested). As our enrollment increased, he developed online registration systems that could collect and update information from parents, teachers, students and researchers. He has also sustained our legacy websites, such as *DNAi*, *Inside Cancer*, and *YGYH*. When the pandemic hit, he facilitated our transition to virtual programming and helped us launch all of our virtual content—developing tools for the *On-Demand* program. Cornel is now working remotely as a software backend engineer for Vinli Inc. based in Dallas, Texas, a cloud-based data intelligence platform for mobility and transportation.

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. This year an amazing group of interns helped out, and we said farewell as others left for college:

High School Interns

Raymond Bailey, Longwood High School
Raquel Belkin, Syosset High School
Hayden Calabretta, Cold Spring Harbor High School
Kevin Darcy, Longwood High School
Lauren Graziosi, Syosset High School
Min Hur, Jericho Senior High School
Megan Jung, Jericho Senior High School
Sandhya LoGalbo, St. Dominic High School
Brianna MacDonald, Commack High School
Rachel Morina, Huntington High School
Maggie Wang, Northport High School
Matthew Warner, Saint Mary's High School

High School Interns Departing for College

Timothy Broadbent, Colby College
Kaela Deriggi, The George Washington University
Ethan McGuinness, Northeastern University
Neal Mehta, Boston College
Aveline Roderick, Boston College

College Interns

Taehwan Cha, New York University
Christopher Cizmeciyan, Stony Brook University
Isabella Martino, Stony Brook University
Jillian Maturo, Boston College
John O'Hara, University of Richmond
Michael Stabile, Cornell University
Nicholas Stabile, University of Notre Dame

David Micklos
DNA Learning Center Executive Director

2021 Grants

Grantor	Program	Duration of Grant	2021 Funding+
FEDERAL GRANTS			
National Institutes of Health	*Citizen DNA Barcode Network*	6/20–3/25	$252,292
National Science Foundation	*Implementing DNA Barcoding for Course-Based Undergraduate Research Experiences*	10/18–9/23	$262,922
National Science Foundation	*CyVerse: Cyberinfrastructure for the Life Sciences*	8/18–7/23	$164,532
National Science Foundation	*RCN-UBE: Establishing a Genomics Education Alliance: Steps Towards Sustainability*	9/18–8/22	$1,573
National Science Foundation	InnovATE*BIO* National Biotechnology Education Center	10/19–9/24	$175,444
National Science Foundation	*What Works in Workshops-Evolving Short Format Training to Serve Life Science STEM Professionals in the 21st Century*	3/21–9/22	$14,051
NON-FEDERAL GRANTS			
Beijing No. 166 High School	Chinese Collaboration Agreement	7/19–6/22	$0
Breakthrough Prize Foundation	Laboratory Design and Teacher Training for Breakthrough Junior Challenge Prize Winners	12/15–12/22	$18,224
Health Park	Health Park Agreement	12/15–12/22	$864
Pinkerton Foundation	*Urban Barcode Research Program*	1/21–5/22	$77,584
Richard Lounsbery Foundation	*Developing Independent Student Marine Biodiversity Research Using eDNA*	10/17–12/21	$2,513
Paul Taubman	Paul Taubman support for *DNALC NYC* at City Tech Exhibition Development	6/21–6/22	$113,396
The Simons Foundation	*Urban Barcode Research Program*	12/17–8/22	$18,992
William Townsend Porter Foundation	*Harlem DNA Lab* for Underprivileged Students	1/20–1/22	$2,983
Office of Brooklyn Borough President	*DNALC NYC* at City Tech Video Wall	10/21–10/22	$87,010
Hudson River Park Trust	Environmental DNA Survey in Hudson River Park's Estuarine Sanctuary	1/20–12/21	$54,926
NY Harbor Foundation	Billion Oyster Project	6/20–12/21	$5,887
Department of Design and Construction	NYC-Department of Design & Construction *DNALC NYC*		$438,336
National Grid Foundation	Genetics Education Program & Advanced Genetics	9/20–9/21	$15,000

+ Includes direct and indirect costs.

School Membership Programs

The following schools and school districts participated in these membership programs of the **Dolan DNALC**:

Sustaining Memberships

Bellmore-Merrick Central High School District	$3,000	Oceanside Union Free School District	$3,000
Elwood UFSD	$3,000	Oyster Bay-East Norwich Central School District	$3,000
Herricks Union Free School District	$3,000	Plainview-Old Bethpage Central School District	$3,000
Huntington	$3,000	Portledge School	$3,000
Island Trees	$3,000	Port Washington Union Free School District	$3,000
Jericho High School	$3,000	Roslyn Union Free School District	$3,000
Levittown Union Free School District	$3,000	Syosset Central School District	$3,000
North Shore Central School District	$1,750	Yeshiva University High School for Girls	$3,000

Associate Memberships

Glen Cove Central School District	$16,000	St. Dominic High School	$16,500

Partner Memberships

Cold Spring Harbor Central School District	$33,000	Massapequa Union Free School District	$33,000
Long Beach Central School District	$33,000		

The following schools participated in these membership programs of the ***DNALC NYC* at City Tech**:

Sustaining Membership

Stuyvesant High School	$3,000

Associate Membership

Portfolio School	$16,500

Partner Memberships

The Chapin School	$33,000	St. David's School	$26,150
Lycée Français de NY	$33,000	Fontbonne Hall	$33,000
Marymount School of NY	$33,000		

The following school participated in this membership program of the ***Regeneron DNALC***:

Sustaining Membership

Archbishop Stepinac High School	$3,000

Sites of Major Faculty Workshops

Program Key: *Middle School* High School **College**

State	Institution	Year(s)
VIRTUAL	Host: **Atlanta University Center Consortium, Atlanta, Georgia**	**2021**
	Host: **Bowie State University, Bowie, Maryland**	2020
	Host: **DNA Learning Center, New York**	2020
	Host: *Harlem DNA Lab* and *Regeneron DNALC*, Sleepy Hollow, New York	2020
	Co-host: **James Madison University, Harrisonburg, Virginia**	**2020, 2021 (3)**
	Host: **North Carolina State University, Raleigh, North Carolina**	**2021**
	Co-hosts: **University of Arizona, Tucson, Arizona** & **DNA Learning Center, NY**	2020
	Host: **Quantitative Undergraduate Biology Education and Synthesis (QUBES) Project**	2020
ALABAMA	University of Alabama, Tuscaloosa	1987–90
	Hudson Alpha Institute, Huntsville	**2014**
ALASKA	**University of Alaska, Anchorage**	**2012**
	University of Alaska, Fairbanks	**1996**
ARIZONA	Arizona State University, Tempe	2009
	Tuba City High School	1988
	University of Arizona, Tucson	**2011, 2019–20**
	United States Department of Agriculture, Maricopa	**2012**
ARKANSAS	Henderson State University, Arkadelphia	1992
	University of Arkansas, Fayetteville	**2017, 2019**
	University of Arkansas, Little Rock	**2012**
	University of Arkansas for Medical Sciences, Little Rock	**2019**
CALIFORNIA	**California State University, Dominguez Hills**	**2009**
	California State University, Fullerton	**2000**
	California State University, Long Beach	**2015**
	California Institute of Technology, Pasadena	**2007**
	Chan-Zuckerberg BioHub, San Francisco	**2018**
	Canada College, Redwood City	1997
	City College of San Francisco	2006
	City College of San Francisco	**2011, 2013**
	Contra Costa County Office of Education, Pleasant Hill	2002, 2009
	Foothill College, Los Altos Hills	**1997**
	Harbor-UCLA Research & Education Institute, Torrance	2003
	Los Angeles Biomedical Research Institute (LA Biomed), Torrance	**2006**
	Laney College, Oakland	1999
	Lutheran University, Thousand Oaks	1999
	Oxnard Community College, Oxnard	2009
	Pasadena City College	**2010**
	Pierce College, Los Angeles	**1998**
	Salk Institute for Biological Studies, La Jolla	2001, 2008
	San Francisco State University	**1991**
	San Diego State University	**2012**
	San Jose State University	**2005**
	Santa Clara University	2010
	Scripps Institute, San Diego	**2019**
	Southwestern College, Chula Vista	**2014–15**
	Stanford University, Palo Alto	**2012**
	University of California, Berkeley	**2010, 2012**
	University of California, Davis	1986

	University of California, Davis	**2012, 2014–15**
	University of California, Long Beach	**2015**
	University of California, Northridge	**1993**
	University of California, Riverside	2011
	University of California, Riverside	**2012**
	University of California, San Francisco	**2015**
COLORADO	Aspen Science Center	2006
	Colorado College, Colorado Springs	1994, 2007
	Colorado State University, Fort Collins	**2013, 2018**
	Community College of Denver	**2014**
	United States Air Force Academy, Colorado Springs	**1995**
	University of Colorado, Denver	1998, 2009–10
CONNECTICUT	Choate Rosemary Hall, Wallingford	1987
	Jackson Laboratory, Farmington	**2016**
DELAWARE	**University of Delaware, Newark**	**2016**
DISTRICT OF COLUMBIA	**Howard University, Washington**	**1992, 1996, 2009–10**
FLORIDA	Armwood Senior High School, Tampa	1991
	Florida Agricultural & Mechanical University, Tallahassee	2007–08
	Florida Agricultural & Mechanical University, Tallahassee	**2011**
	Florida SouthWestern State University, Fort Myers	**2015**
	North Miami Beach Senior High School	1991
	Seminole State College, Sanford	**2013–14**
	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
	Gwinnett Technical College, Lawrenceville	**2011–12**
	Morehouse College	**1991, 1996**
	Morehouse College	1997
	Spelman College, Atlanta	**2010**
	University of Georgia, Athens	**2015**
HAWAII	Kamehameha Secondary School, Honolulu	1990
	University of Hawaii at Manoa	**2012**
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
	Kings College, Chicago	**2014**
	University of Chicago	**1992, 1997, 2010**
	University of Southern Illinois, Carbondale	**2016**
INDIANA	Butler University, Indianapolis	1987
	Purdue University, West Lafayette	**2012**
IOWA	Drake University, Des Moines	1987
KANSAS	University of Kansas, Lawrence	1995
KENTUCKY	**Bluegrass Community & Technical College, Lexington**	**2012–14**
	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

	Southern University at New Orleans	**2012**
	University of New Orleans	**2018**
MAINE	Bates College, Lewiston	1995
	Southern Maine Community College	**2012–13**
	Foundation for Blood Research, Scarborough	2002
MARYLAND	Annapolis Senior High School	1989
	Bowie State University	**2011, 2015**
	Frederick Cancer Research Center	1995
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools	1990–92
	National Center for Biotechnology Information, Bethesda	2002
	St. John's College, Annapolis	*1991*
	University of Maryland, School of Medicine, Baltimore	**1999**
MASSACHUSETTS	**Arnold Arboretum of Harvard University, Roslindale**	**2011**
	Beverly High School	1986
	Biogen Idec, Cambridge	2002, 2010
	Boston University	**1994, 1996**
	CityLab, Boston University School of Medicine	1997
	Dover-Sherborn High School, Dover	1989
	Randolph High School	1988
	The Winsor School, Boston	1987
	Whitehead Institute for Biomedical Research, Cambridge	2002
MICHIGAN	Athens High School, Troy	1989
	Schoolcraft College, Livonia	**2012**
MINNESOTA	**American Society of Plant Biologists, Minneapolis**	**2015**
	Minneapolis Community and Technical College, Madison	2009
	Minneapolis Community and Technical College, Madison	**2013**
	University of Minnesota, St. Paul	2005
	University of Minnesota, St. Paul	**2010**
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990–91
	Rust College, Holly Springs	**2006–08, 2010**
MISSOURI	**St. Louis Science Center**	**2008–10**
	Stowers Institute for Medical Research, Kansas City	2002, 2008
	University of Missouri, Columbia	**2012**
	Washington University, St. Louis	1989
	Washington University, St. Louis	**1997, 2011, 2019**
MONTANA	**Montana State University, Bozeman**	**2012**
NEBRASKA	**University of Nebraska-Lincoln, Lincoln**	**2014**
NEVADA	University of Nevada, Reno	1992, 2014
NEW HAMPSHIRE	Great Bay Community College, Portsmouth	2009
	New Hampshire Community Technical College, Portsmouth	**1999**
	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
	Los Alamos National Lab	**2017**
	New Mexico State University, Las Cruces	**2017**
	Santa Fe Community College, Santa Fe	**2015**
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
	Canisius College, Buffalo	**2011**
	City College of New York	2012
	Cold Spring Harbor High School	1985, 1987
	Cold Spring Harbor Laboratory	**2014–15, 2018–19**
	Columbia University, New York	**1993**
	Cornell University, Ithaca	**2005**
	DeWitt Middle School, Ithaca	*1991, 1993*
	Dolan DNA Learning Center	1988–95, 2001–04, 2006–09, 2015–19
	Dolan DNA Learning Center	**1990, 1992, 1995, 2000–11**
	Dolan DNA Learning Center	*1990–92*
	DNA Learning Center *West*	2005
	DNA Learning Center NYC	2019, 2021
	Environmental Science Center, Bergen Beach, Brooklyn	2015–16
	Fostertown School, Newburgh	*1991*
	Harlem DNA Lab, East Harlem	2008–09, 2011–13, 2016–19
	***Harlem DNA Lab*, East Harlem**	**2015–16**
	Huntington High School	1986
	Irvington High School	1986
	K-12 Summer Institute, Kerrville	2019
	John Jay College of Criminal Justice	2009
	Junior High School 263, Brooklyn	*1991*
	Lindenhurst Junior High School	*1991*
	Math for America	**2017–19**
	Michel J. Petrides School, Staten Island	2018
	Mount Sinai School of Medicine, New York	1997
	Nassau Community College, Garden City	**2013**
	New York Botanical Garden, Bronx	**2013**
	New York City Department of Education	2007, 2012
	New York City Technical College (City Tech)	2018
	New York Institute of Technology, New York	2006
	New York Institute of Technology, New York	**2006**
	Orchard Park Junior High School	*1991*
	Plainview-Old Bethpage Middle School	*1991*
	Regeneron Phamaceuticals, Inc	**2019**
	School of Visual Arts, New York	**2017**
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–90, 2015–18
	State University of New York, Stony Brook	**2014, 2016**
	Stuyvesant High School, New York	1998–99
	The Rockefeller University, New York	2003, 2015–16
	The Rockefeller University, New York	**2010**
	Titusville Middle School, Poughkeepsie	*1991, 1993*
	Trudeau Institute, Saranac Lake	2001
	Union College, Schenectady	2004
	United States Military Academy, West Point	**1996**
	Wheatley School, Old Westbury	1985
NORTH CAROLINA	CIIT Center for Health Research, Triangle Park	2003
	North Carolina Agricultural & Technical State University, Greensboro	**2006–07, 2009–11**
	North Carolina School of Science, Durham	1987
	North Carolina State University, Raleigh	**2012, 2018**
NORTH DAKOTA	**North Dakota State University, Fargo**	**2012**

OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	Langston University, Langston	2008
	North Westerville High School	1990
	The Ohio State University, Wooster	**2016**
OKLAHOMA	**Oklahoma City Community College**	**2000**
	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
	Tulsa Community College, Tulsa	**2012–14**
OREGON	Kaiser Permanente-Center for Health Research, Portland	2003
	Linfield College, McMinnville	**2014**
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy	1988
	Kimmel Cancer Center, Philadelphia	2008
RHODE ISLAND	Botanical Society of America, Providence	2010
SOUTH CAROLINA	**Clemson University**	**2004, 2015**
	Medical University of South Carolina, Charleston	1988
	University of South Carolina, Columbia	**1988**
SOUTH DAKOTA	**South Dakota State University, Brookings**	**2015**
TENNESSEE	NABT Professional Development Conference, Memphis	2008
TEXAS	Austin Community College – Rio Grande Campus	2000
	Austin Community College – Eastview Campus – Roundrock Campus	**2007–09, 2013**
	Austin Community College – Roundrock Campus	**2012**
	Austin Community College - Austin	**2018**
	Houston Community College Northwest	**2009–10**
	J.J. Pearce High School, Richardson	1990
	Langham Creek High School, Houston	1991
	University of Lone Star College, Kingwood	**2011**
	Midland College	2008
	Southwest Foundation for Biomedical Research, San Antonio	2002
	Taft High School, San Antonio	1991
	Texas A&M University, College Station, TX	**2013**
	Texas A&M University, Prairie View, TX	**2013**
	Texas A & M, AG Research and Extension Center, Weslaco	2007
	Trinity University, San Antonio	**1994**
	University of Texas, Austin	**1999, 2004, 2010, 2012**
	University of Texas, Brownsville	**2010**
UTAH	**Brigham Young University, Provo**	**2012**
	University of Utah, Salt Lake City	1993
	University of Utah, Salt Lake City	**1998, 2000**
	Utah Valley State College, Orem	**2007**
VERMONT	University of Vermont, Burlington	1989
	Champlain Valley Union High School	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	James Madison University, Harrisonburg	**2017**
	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
	Virginia Polytechnic Institute and State University, Blacksburg	**2005, 2008–09**
WASHINGTON	Fred Hutchinson Cancer Research Center, Seattle	1999, 2001, 2008

	Shoreline Community College	2011, 2012
	University of Washington, Seattle	**1993, 1998, 2010**
WEST VIRGINIA	**Bethany College**	**1989**
WISCONSIN	Blood Center of Southeastern Wisconsin, Milwaukee	2003
	Madison Area Technical College/Madison Area College	**1999, 2009, 2011–14**
	Marquette University, Milwaukee	1986–87
	University of Wisconsin, Madison	1988–89
	University of Wisconsin, Madison	**2004, 2012**
WYOMING	University of Wyoming, Laramie	1991
PUERTO RICO	**Universidad del Turabo, Gurabo, Puerto Rico**	**2011, 2012, 2014**
	University of Puerto Rico, Mayaguez	1992
	University of Puerto Rico, Mayaguez	**1992**
	University of Puerto Rico, Rio Piedras	**1993**
	University of Puerto Rico, Rio Piedras	1994
	University of Puerto Rico, San Juan	**2019**
AUSTRALIA	Walter and Eliza Hall Institute and University of Melbourne	1996
	EMBL/Australian Bioinformatics Resource, University of Melbourne	**2016**
	University of Western Australia, Perth	**2018**
AUSTRIA	**Vienna Open Lab, Vienna**	**2007, 2012**
	Technical University of Graz	**2019**
CANADA	Red River Community College, Winnipeg, Manitoba	1989
	University of Quebec, Montreal	**2018**
CHINA	Beijing No. 166 High School, Beijing	2013–19
	Ho Yu College, Hong Kong	**2009**
DENMARK	**Faroe Genome Project, Torshavn, Faroe Islands**	**2013**
GERMANY	Urania Science Center, Berlin	2008
IRELAND	**European Conference on Computational Biology/Intelligent System for Molecular Biology Conference, Dublin**	**2015**
	University College Dublin	**2018**
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
	Langebio/Cinvestav, Irapuato	**2016**
NIGERIA	Godfrye Okoye University, Enugu, Nigeria	2013, 2018
PANAMA	**University of Panama, Panama City**	**1994**
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	**North-West University, Potchefstroom**	**2016**
	South African Bioinformatics Society, Durban	**2016**
SWEDEN	Kristineberg Marine Research Station, Fiskebackgkil	1995
	Uppsala University	2004
THE NETHERLANDS	**International Chromosome Conference, Amsterdam**	**2007**
	Wageningen University and Research Center, Wageningen	**2014**
UNITED KINGDOM	**Earlham Institute, Norwich**	**2018**
	The Genome Analysis Center, Norwich	**2015**
	University of York, York	**2017**
	Wellcome Trust Conference Center, Hinxton	**2012–13**
	University of Warwick, Coventry	**2013**

Workshops, Meetings, Collaborations, and Site Visits

January 13	*Saturday DNA!* "Virtual Lab: DNA Extraction from Strawberries," DNALC
	"Meet a Scientist: Dr. Lloyd Trotman," Virtual Event, DNALC
January 16	*Saturday DNA!* "Virtual Lab: DNA Extraction from Strawberries," DNALC
January 20	*Saturday DNA!* "Virtual Lab: As the Worm Turns," DNALC
January 23	*Saturday DNA!* "Virtual Lab: As the Worm Turns," DNALC
January 26	NIH *Barcoding US Ants* Mini Virtual Symposium, DNALC
January 27	*Saturday DNA!* "Virtual Lab: Cracking the Code," DNALC
January 28	Agricultural Biotechnology: Emerging Technologies and Insights Mini Virtual Symposium 2021, "Agricultural Genomics: The Rise of Genomes," "Emerging Trends in Agricultural Diagnostics," "Clones, Carbon and Climate Change: The Epigenetics of Oil Production," The InnovATE*BIO* National Center for Biotechnology Education, Austin Community College, Austin, Texas
January 29	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
January 30	*Saturday DNA!* "Virtual Lab: Cracking the Code," DNALC
	Green Genes Workshop, DNALC
	AP Bio/Restriction Analysis Part I Workshop, DNALC
February 1	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
February 3	*Saturday DNA!* "Virtual Lab: DIY Electrophoresis Chamber," DNALC
	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
February 5	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
February 6	*Saturday DNA!* "Virtual Lab: DIY Electrophoresis Chamber," DNALC
	Workshop, DNALC
	AP Bio/Restriction Analysis Part II Workshop, DNALC
February 13	*Green Genes* Workshop, DNALC
	AP Bio/Bacterial Transformation Workshop, DNALC
February 16	"DNA 101" Workshop, DNALC
	Bacterial Transformation Workshop, DNALC
	DNA Barcoding Virtual Workshop, DNALC
Feb 16-19	*Urban Barcode Research Program* Conservation Genetics Virtual Workshop, *DNALC NYC* at City Tech
February 17	"Got Lactase?" Workshop, DNALC
	"Forensics: Trace Evidence," Workshop, DNALC
February 18	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
February 19	"Gene Therapy," Workshop, DNALC
	"Restriction Analysis," Workshop, DNALC
	DNA Barcoding Virtual Workshop, DNALC
	NIH *Citizen DNA Barcode Network* Collaborator Virtual Workshop, DNALC
February 20	*Green Genes* Workshop, DNALC
	AP Bio/Human DNA Fingerprinting Workshop, DNALC
February 23	*DNA Barcoding* Virtual Workshop, DNALC
February 25	"DNA Fingerprinting," Workshops, DNALC
February 26	*DNA Barcoding* Virtual Workshop, DNALC
February 27	*Green Genes* Workshop, DNALC
	AP Bio/DNA Barcoding, Part I Workshop, DNALC
March 2	*DNA Barcoding* Virtual Workshop, DNALC
March 3	*Saturday DNA!* "Virtual Lab: Selection Detection," DNALC
March 5	*DNA Barcoding* Virtual Workshop, DNALC
March 6	*Saturday DNA!* "Virtual Lab: Selection Detection," DNALC

	Green Genes Workshop, DNALC
	AP Bio/DNA Barcoding, Part II Workshop, DNALC
March 9	*DNA Barcoding* Virtual Workshop, DNALC
March 11	"Meet a Scientist: Miriam Ferrer Gonzalez," Virtual Event, DNALC
March 12, 16	*DNA Barcoding* Virtual Workshop, DNALC
March 17	NIH *Barcode Long Island* Virtual Open Lab, DNALC
March 19, 23, 26	*DNA Barcoding* Virtual Workshop, DNALC
March 23	*DNA Barcoding* Virtual Workshop, DNALC
March 26	*DNA Barcoding* Virtual Workshop, DNALC
March 27	*AP Bio/Restriction Analysis*, Part I Workshop DNALC
March 29–April 2	*Urban Barcode Research Program DNA Barcoding* and Bioinformatics Virtual Workshop, *DNALC NYC* at City Tech
	Spring Break Workshops, T*he Diversity of Life*, *Human Mitochondrial Sequencing: Part 1*, *Infectious Disease*, *Bacterial Transformation*, *Mendelian Genetics: Build a Creature*, *Restriction Analysis*, *Agar Art*, *Purification of Green Fluorescent Protein*, *Human Mitochondrial Sequencing*, DNALC
April 3	*AP Bio/Restriction Analysis*, Part II Workshop, DNALC
April 7	Informational Session, Virtual, *DNALC NYC* at City Tech
	DNA Barcoding Virtual Presentation for iNaturalist Discord Server Group, San Francisco, California, DNALC
April 8	"Meet a Scientist: Alexa Pagliaro," Virtual Webinar, DNALC
April 10	*Saturday DNA!* "Virtual Lab: Candy Bar Phylogenetics," DNALC
	AP Bio/Bacterial Transformation Workshop, DNALC
April 14–15	Informational Sessions, Virtual, *DNALC NYC* at City Tech
April 16	NSF Northeast Big Data Innovation Hub, "Student Data Corps Data Science Career Panel," Virtual Public Lecture, Data Science Institute, Columbia University, New York, New York
April 17	*Saturday DNA!* "Virtual Lab: History and Mystery of Cell Theory," DNALC
	AP Bio/Human DNA Fingerprinting Workshop, DNALC
	NIH *Barcode Long Island* Virtual Open Lab, DNALC
	DNA Extractions at Brooklyn Outdoor Earth Day Event, Brooklyn, New York
April 19	Earth Day/March for Science Virtual Science Expo, New York, New York
April 21	Informational Session, Virtual, *DNALC NYC* at City Tech
April 24	*Saturday DNA!* "Virtual Lab: Less is More: Population Size and Genetic Drift," DNALC
	AP Bio/DNA Barcoding, Part I Workshop, DNALC
April 28	NIH *Barcode Long Island* Virtual Open Lab, DNALC
May 1	*Saturday DNA!* "Virtual Lab: Microbe Mania!" DNALC
	AP Bio/DNA Barcoding, Part II Workshop, DNALC
May 5	Informational Session, Virtual, *DNALC NYC* at City Tech
May 8	*Saturday DNA!* "Virtual Lab: Ancient Ancestors & Me," DNALC
May 13	"Meet a Scientist: Dr. Hannah Meyer," Virtual Webinar, DNALC
May 14	*Mystery of Anastasia* Virtual Presentation for Siemens Healthineers, Malvern, Pennsylvania, DNALC
May 15	*Saturday DNA!* "Virtual Lab: EYE-volution!" DNALC
May 19-20	Informational Sessions, Virtual, *DNALC NYC* at City Tech
May 20–21, 24–25	CyVerse Data Carpentry Genomics Virtual Workshop, Atlanta University Center Consortium, Atlanta, Georgia, DNALC
May 24–27	NIH SciEd 2021 Virtual Conference, "*Citizen DNA Barcode Network*: Support for Community-Based, Hands-On Science," Poster Session, Washington, D.C.
May 26–27	Informational Sessions, Virtual, *DNALC NYC* at City Tech
May 26–28	Introduction to Bioinformatics with CyVerse Virtual Workshop, North Carolina State University, Raleigh, North Carolina, DNALC

June 1	*Urban Barcode Project*/*Urban Barcode Research Program*/*Barcode Long Island*/*US Ants* DNA Barcoding Virtual Student Symposium, DNALC and *DNALC NYC* at City Tech
June 7–16	*DNA Barcoding* for CURES Virtual Workshop, James Madison University, Harrisonburg, Virginia, DNALC
June 8	International Applied Microbiology Virtual Conference 2021, "Introduction to RNA-Seq with the Kallisto and Sleuth Workflows," Faculty/Student Workshop, Society for Applied Microbiology, London, United Kingdom
June 9–10	NYC DOE STEM Virtual Conference, "The *Urban Barcode Project*—Hands-on Science at Home and in School," Teacher Workshop, Expo Hall, Long Island City, New York
June 10	"Meet a Scientist: Dr. Peter Koo," Virtual Webinar, DNALC
June 17	*DNA Barcoding* Training with Long Island Science Center, DNALC
June 21–25	*DNA Metabarcoding for CURES* Virtual Workshop, James Madison University, Harrisonburg, Virginia
June 28–July 2	*DNA Science* Workshop, DNALC
	World of Enzymes Workshop, DNALC
	Green Genes Workshop, DNALC
	DNA Science Workshop, DNALC
	Fun with DNA Workshop, DNALC
	DNA Science Workshop, *DNALC NYC* at City Tech
	Fun with DNA Workshop, *DNALC NYC* at City Tech
	Forensic Detectives Workshop, *DNALC NYC* at City Tech
	Urban Barcode Project Teacher Training Workshop, *DNALC NYC* at City Tech
June 29–July 1	CGEMS 2021 – Getting Started with R and CyVerse Virtual Workshop, James Madison University, Harrisonburg, Virginia, DNALC
July 5–9	*Genome Science* Workshop, DNALC
	Fun with DNA Workshop, DNALC
	Forensic Detectives Workshop, DNALC
	World of Enzymes Workshop, DNALC
	Fun with DNA Workshop, *DNALC NYC* at City Tech
	World of Enzymes Workshop, *DNALC NYC* at City Tech
	Bridging the Gap STEP: Fun with DNA Virtual Workshop, DNALC
July 12–16	*DNA Science* Workshop, DNALC
	Green Genes Workshop, DNALC
	Fun with DNA Workshop, DNALC
	Green Genes Workshop, DNALC
	BioCoding Workshop, DNALC
	DNA Science Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Conservation Genetics Workshop, *DNALC NYC* at City Tech
	Bridging the Gap Fun with DNA Virtual Workshop, *Regeneron DNALC*
	Bridging the Gap Forensic Detectives Virtual Workshop, *Regeneron DNALC*
	DNA Barcoding Workshop, Francis Lewis High School, Fresh Meadows, New York
July 19–23	*DNA Science* Workshop, DNALC
	Forensic Detectives Workshop, DNALC
	World of Enzymes Workshop, DNALC
	Fun with DNA Workshop, DNALC
	Forensic Detectives Workshop, *DNALC NYC* at City Tech
	Fun with DNA Workshop, *DNALC NYC* at City Tech
	DNA Science Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Barcoding Workshop, *DNALC NYC* at City Tech

	Urban Barcode Research Program Conservation Genetics Workshop, *Harlem DNA Lab*
	Bridging the Gap Forensic Detectives Virtual Workshop, *Regeneron DNALC*
July 26–30	*DNA Science* Workshop, DNALC
	Green Genes Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Barcoding Workshop, DNALC
	Genome Science Workshop, *DNALC NYC* at City Tech
	World of Enzymes Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Conservation Genetics Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Barcoding Workshop, *Harlem DNA Lab*
	Genome Science Virtual Workshop, DNALC
	Bridging the Gap STEP World of Enzymes Virtual Workshop, DNALC & *Regeneron DNALC*
	BioCoding Virtual Workshop, DNALC
July 26	"Extending the Possibilities of Biology with Open Science," Virtual Student Lecture, Prairie View A & M University College of Engineering, Prairie View, Texas, DNALC
July 30	NIH *Citizen DNA Barcode Network* Collection Event, Sweetbriar Nature Center, Smithtown, New York
August 2–6	*Green Genes* Workshop, DNALC
	Genome Science Workshop, DNALC
	Fun with DNA Workshop, DNALC
	Citizen DNA Barcode Network Barcoding Workshop, DNALC
	DNA Barcoding Workshop, *DNALC NYC* at City Tech
	Green Genes Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Barcoding Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Conservation Genetics Workshop, *Harlem DNA Lab*
	Genome Science Virtual Workshop, DNALC
	Fun with DNA Virtual Workshop, *Regeneron DNALC*
	Forensic Detectives Workshop, Friends Academy, Locust Valley, New York
August 3–5	*DNA Metabarcoding for CURES* Virtual Workshop, James Madison University Harrisonburg, Virginia, DNALC
August 9–13	*DNA Science* Workshop, DNALC
	STARS DNA Barcoding Workshop, DNALC
	Forensic Detectives Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Science Workshop, *DNALC NYC* at City Tech
	Forensic Detectives Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Conservation Genetics Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Barcoding Workshop, *Harlem DNA Lab*
	World of Enzymes Virtual Workshop, DNALC
	Forensic Detectives Virtual Workshop, *Regeneron DNALC*
August 16–20	*DNA Science* Workshop, DNALC
	Green Genes Workshop, DNALC
	World of Enzymes Workshop, DNALC
	Fun with DNA Workshop, DNALC
	STARS BioCoding Workshop, DNALC
	Fun with DNA Workshop, *DNALC NYC* at City Tech
	Genome Science Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Barcoding Workshop, *DNALC NYC* at City Tech

	DNA Barcoding Virtual Workshop, DNALC
August 23–27	*Sequence a Genome!* Workshop, DNALC
	DNA Barcoding Workshop, DNALC
	Forensic Detectives Workshop, DNALC
	WiSE *Fun with DNA* Workshop, DNALC
	DNA Science Workshop, *DNALC NYC* at City Tech
	World of Enzymes Workshop, *DNALC NYC* at City Tech
	Urban Barcode Research Program Bootcamp Workshop, *DNALC NYC* at City Tech
	Fun with DNA Virtual Workshop, DNALC
	DNA Barcoding Virtual Workshop, DNALC
August 25	Site Visit by Eric Adams, Brooklyn Borough & Russ Hotzler, City Tech, *DNALC NYC* at City Tech
August 30–September 3	*DNA Science* Workshop, DNALC
	Fun with DNA Workshop, DNALC
	Green Genes Workshop, DNALC
	Green Genes Workshop, *DNALC NYC* at City Tech
September 2	Chan Zuckerberg Initiative Training and Education for Open Science Virtual Workshop, Redwood City, California, DNALC
September 13,15	NSF Virtual Panel, Alexandria, Virginia
September 20	Site Visit by Greg Borman, Department of STEM, Office of Curriculum Instruction & Professional Learning, NYC Department of Education, & Sheldon Young, ACCESS Citywide, NYC Department of Education, New York, New York, *DNALC NYC* at City Tech
September 21,23	NSF Virtual Panel, Alexandria, Virginia
September 24	*DNALC NYC* at City Tech Ribbon Cutting Event
September 29	American Society of Cell Biology Public Engagement Webinar, "Relevance and Rapport; Promoting Inclusion through Public Engagement," Virtual Lecture Rockville, Maryland
September 30	Site Visit by Joseph Oleniczak and Kissaou Tchedre, Austin Community College, Austin, Texas, DNALC & *DNALC NYC* at City Tech
October 1	"A Day in the Life" Event, Massapequa High School, Massapequa, New York
October 5	*Urban Barcode Research Program* Student Orientation, Virtual and *DNALC NYC* at City Tech
October 8	CyVerse Webinar Series Virtual Teacher Workshop, "CyVerse Visual Interactive Computing Environment," DNALC
October 16	STEM Teachers NYC Training "Intro to Biotech, Part 1," *DNALC NYC* at City Tech
October 19	Site Visit by Nick Greiner and Maria Scoutas, Consul General's Office of Australia, New York, New York, with Bruce Stillman, DNALC
October 20	Regeneron Virtual Training Session "Day for Doing Good," DNALC
October 23	STEM Teachers NYC Training "Intro to Biotech, Part 2," *DNALC NYC* at City Tech
	Saturday DNA! "Tracking Traits," DNALC
October 26	Day for Doing Good Science Virtual Expo, "DNA Extraction from Wheat Germ," Regeneron Pharmaceuticals, Tarrytown, New York
October 27	Massapequa School District Teacher Training Workshops, "Barcoding and Bioinformatics," and "DNA Extraction, Mendelian Inheritance, Bacteria & Antibiotics," & "Otzi the Iceman," DNALC Fall Open House, *DNALC NYC* at City Tech
October 28	NIH *Citizen DNA Barcode Network* Meeting at Jones Beach Energy and Nature Center, Jones Beach State Park, Wantagh, New York
October 29	Site Visit by Doug Torre, CSHL, DNALC
	Massapequa School District Teacher Training Workshops, "Restriction Analysis," DNALC
October 30	STEM Teachers NYC Training "Intro to Biotech, Part 3," *DNALC NYC* at City Tech
November 2	NIH *Barcode Long Island* Teacher Training Workshop, "DNA Barcoding," DNALC
	Teacher Training Workshop, "Human Mitochondrial Sequencing," DNALC

	Urban Barcode Project Training, Virtual Refresher Course, *DNALC NYC* at City Tech
November 3–5	CSHL Genome Informatics Virtual Conference, "Tools to Facilitate Student Metabarcoding Research," Poster Session, CSHL
November 4	Black Women in Computational Biology Seminar, "Opening Doors—Preparing the Next Generation of Computational Biologists," Virtual Lecture, Philadelphia, Pennsylvania
	Fall Open House, *DNALC NYC* at City Tech
November 8	Fall Open House, *DNALC NYC* at City Tech
November 9	Math for America Teacher Training "Human Mitochondrial Sequencing Part 1," *DNALC NYC* at City Tech
	Brooklyn North Virtual STEM Day Celebration, Brooklyn, New York
November 10	Fall Open House, *Regeneron DNALC*
November 11	*Ötzi the Iceman* Virtual Tour, DNALC
November 13	*Saturday DNA!* "A BOLD Connection," DNALC
November 15	Long Beach School District Teacher Training Workshop, "Bacterial Transformation," DNALC
	Barcode Long Island Virtual Teacher Training, "Bioinformatics," DNALC
November 16	Math for America Teacher Training "Human Mitochondrial Sequencing Part 2," *DNALC NYC* at City Tech
November 18	Fall Open House, *Regeneron DNALC*
	"Meet a Scientist: Dr. Doreen Ware," Virtual Webinar, DNALC
November 19	"Learning New Tricks—Career-spanning Learning in STEM," Virtual Student Lecture, Engaged STEM Scholars Program, Barry University, Miami Shores, Florida
November 23	Math for America Teacher Training "Human Mitochondrial Sequencing Part 3," *DNALC NYC* at City Tech
November 30	Site Visit & Tour by Justin Vázquez-Poritz, City Tech School of Arts and Sciences, Brooklyn, New York, *DNALC NYC* at City Tech
December 2	"Asking the Wrong Questions About American Science Education," Virtual Lecture, American Society for Cell Biology, Rockville, Maryland
	American Society for Cell Biology, Cell Bio Virtual 2021 Teacher Workshop, "Integrating Bioinformatics into Your Courses," Rockville, Maryland
December 2–3	Computing for Teaching and Learning with Jupyter Workshop, George Washington University, Washington D.C.
December 3	Shelter Island High School Science Fair, Shelter Island, New York
December 7, 9	Banbury Life Science Virtual Professional Development Conference, "Making Career-spanning Learning in the Life Sciences Inclusive and Effective for All," CSHL
December 8	Queensborough College Business Industry Leadership Team Kickoff Virtual Teacher Workshop, "Bringing Data into the Classroom," Queens, New York
December 9	CUNY TV Filming, *DNALC NYC* at City Tech
December 10	Site Visit by Brooklyn North e-STEM Team, Brooklyn, New York, *DNALC NYC* at City Tech
December 11	*Saturday DNA!* "A Day in the Life of the Iceman," DNALC
December 14	*Barcode Long Island* Open Lab, DNALC
December 16	Site Visit by Jeremy Seto (CUNY NYCCT) & City Tech Nursing Faculty, Brooklyn, New York, *DNALC NYC* at City Tech
	"Meet a Scientist: Dr. Christopher Vakoc," Virtual Webinar, DNALC

Cold Spring Harbor Laboratory
DNA Learning Center

One Bungtown Road
Cold Spring Harbor, NY 11724

Located at 334 Main Street (Route 25A)
in Cold Spring Harbor Village

Phone 516-367-5170
Fax 516-367-5182
Email dnalc@cshl.edu

DNA Learning Center NYC at City Tech
62 Tillary Street
Brooklyn, New York 11201

Regeneron DNA Learning Center
Regeneron Pharmaceuticals, Inc.
Sleepy Hollow Campus
1 Rockwood Road
Sleepy Hollow, New York 10591

Harlem DNA Lab
2351 First Avenue at 120th Street
East Harlem, New York 10035

Visit us online at
www.dnalc.org