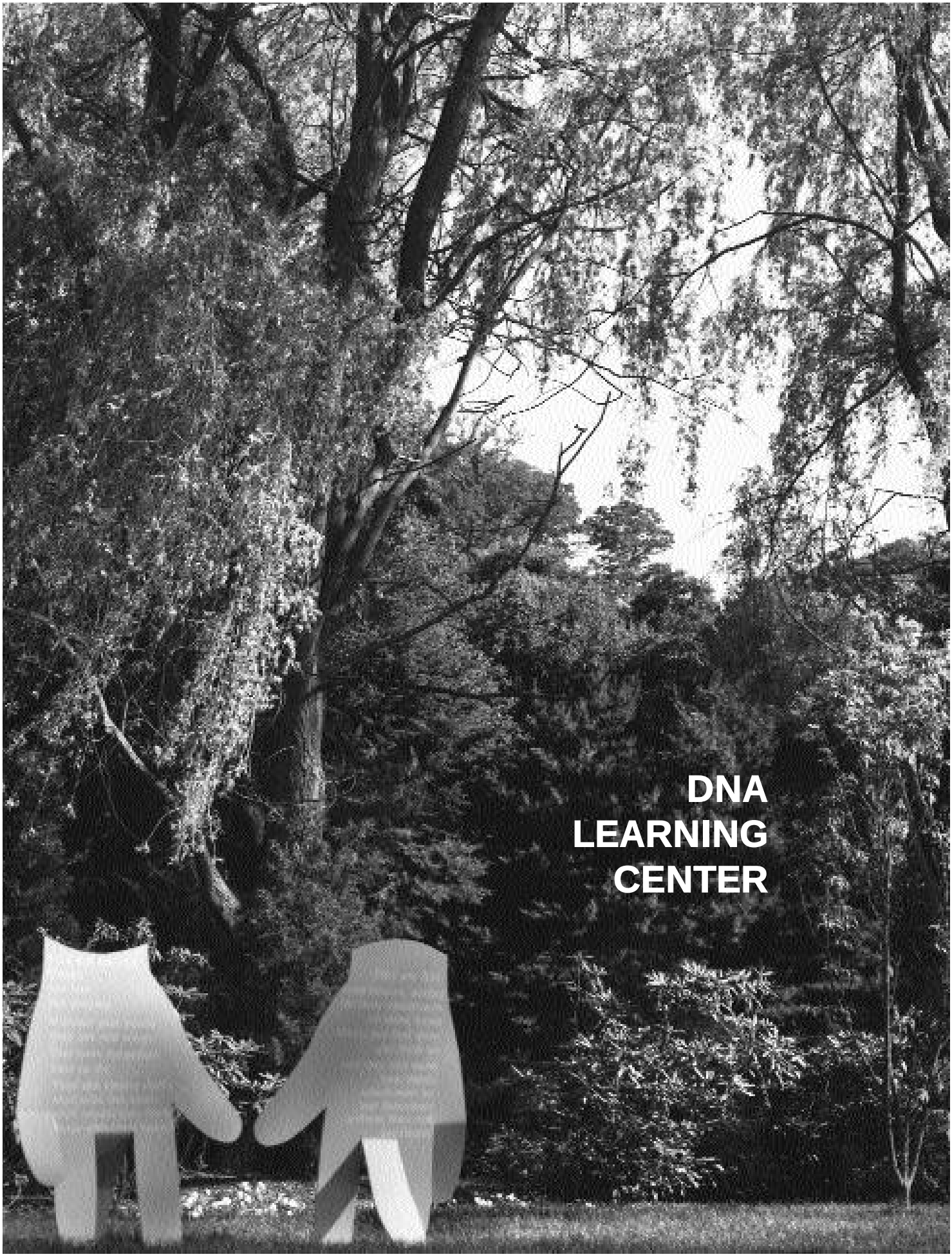

DNA
LEARNING
CENTER

DNA LEARNING CENTER

ADMINISTRATION

David Micklos
Judy Cumella-Korabik
Nancy Daidola
Vin Torti

INSTRUCTION

Scott Bronson
Amanda McBrien
Danielle Sixsmith
Veronique Bourdeau
Elna Carrasco
Maureen Cowan

MULTIMEDIA

Susan Lauter
Shirley Chan
Chun-hua Yang
Susan Conova
Uwe Hilgert

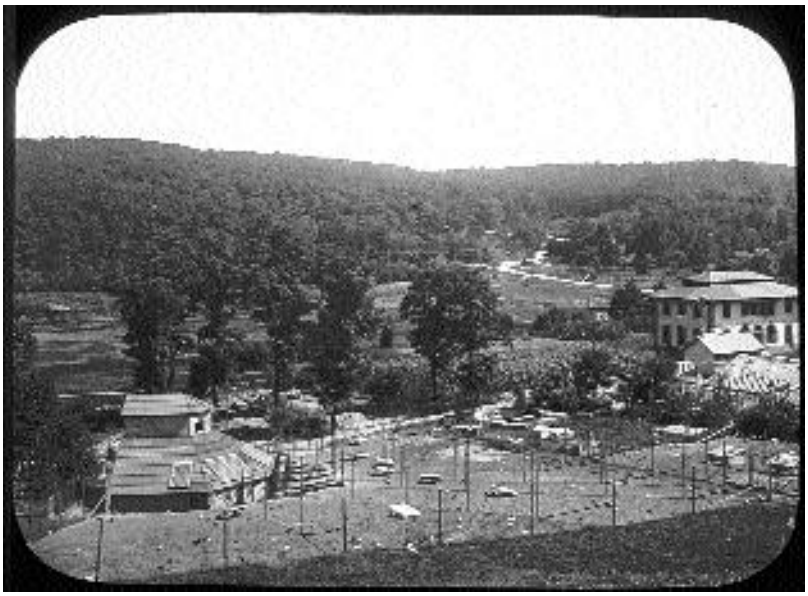
We stand at the threshold of a new century with the whole human genome stretched out before us. Messages from science and the popular media suggest a world of seemingly limitless opportunities to improve human health and productivity. Yet, at the turn of the last century, science and society faced a similar rush to exploit human genetics. The story of eugenics—humankind's first venture into a "gene age"—holds a cautionary lesson for our current preoccupation with genes.

Eugenics was the effort to apply principles of genetics to improve the human race. Most people equate eugenics with the atrocities committed for the sake of racial purity in Nazi Germany. Most are unaware of the "positive" eugenics movement, exemplified in England, which advocated voluntary efforts by families to improve their own heredity. Fewer still realize that a coercive, "negative" eugenics movement flourished in the United States, that it involved numerous prominent scientists and civic leaders, and that it made its intellectual home at the forerunner of the now prestigious Cold Spring Harbor Laboratory.

During the first decade of the 20th century, eugenics was organized as a scientific field by the confluence of Mendelian genetics and experimental breeding. This synthesis was embodied by Charles Benedict Davenport, who is considered the father of the American eugenics movement. When Charles Davenport arrived at Cold Spring Harbor in 1898, he assumed the directorship of The Biological Laboratory, a progressive, if somewhat sleepy, "summer camp" for the study of evolution. Founded in 1890, The Biological Laboratory at Cold Spring Harbor followed in the footsteps of the Marine Biological Laboratory at Woods Hole, Massachusetts (1888). Both had been established in the tradition of seaside biological stations founded along the European coastlines following the publication of Darwin's Origin of Species. The intersection of land and water was thought to be the ideal place to study how organisms had evolved and adapted to fill a multitude of aquatic, semi-aquatic, and terrestrial niches.

Although he had been trained in the classic observation methods of zoology and comparative morphology, Davenport became interested in the new movement that sought to directly recreate evolution in the laboratory. He and a number of other biologists, including Thomas Hunt Morgan, believed that controlled breeding experiments with plants and animals would yield new insight into evolutionary processes. Davenport gained the ear of the board of the Carnegie Institution of Washington, one of several philanthropies formed under Andrew Carnegie's will to disburse the proceeds of the divestiture of his steel holdings. From them, Davenport secured funding to establish a Station for Experimental Evolution at Cold Spring Harbor.

The dedication of the Station's first building, in 1904, offered a prediction about the future of experimental evolution—the keynote speech was delivered by Hugo de Vries, one of three researchers who had recently rediscovered Mendel's laws of genetics. Davenport populated the Station with like-minded researchers, who made agricultural plants and animals their research subjects. The Station took on the aspect of a farm with chicken coops, goat sheds, Manx cats and canaries, and fields of corn and jimsonweed. Many of the researchers at the Station for Experimental Evolution embraced Mendel's laws, and the shorthand popularized by Reginald Punnet, as a means to follow traits through their experimental crosses. For many, the intricacies of genetics eventually subsumed the experimental



The Station for Experimental Evolution, circa 1908. This view from Blackford lawn looking towards Route 25A includes the Carnegie Library beyond the chicken coops. Image source: Harry H. Laughlin Archives, Truman State University.

study of evolution, and in 1920, the Station for Experimental Evolution was quietly renamed the Carnegie Department of Genetics. Thus, the experimental evolutionists had become the first generation of geneticists.

Several years later, Davenport was introduced to Mrs. E.H. Harriman, by way of her daughter, who had taken a summer course at The Biological Laboratory. Mrs. Harriman was the widow of the railroad magnate who had founded the New York Central Railroad and its Grand Central Station in Manhattan. Davenport convinced Mrs. Harriman to contribute $10,000 to establish a Eugenics Record Office (ERO) on property adjacent to the Station for Experimental Evolution, and she later provided a $300,000 endowment.

Davenport recruited Harry Laughlin, a person with whom he shared an interest in chicken breeding, as superintendent of the ERO. Davenport's little book, Eugenics: The Science of Human Improvement by Better Breeding, illustrates how eugenicists sought to transfer lessons from agriculture to human beings. With almost religious zeal, Davenport and Laughlin set out to popularize eugenics. A series of ERO bulletins, including Davenport's Trait Book and How to Make a Eugenical Family Study, helped to standardize methods and nomenclature for pedigree studies. Eugenical News, published by the ERO from 1920 through 1938, was the dominant mouthpiece for the racist and anti-immigration agenda of eugenics research. The ERO also published a number of forms that facilitated data collection. Many families proudly submitted their pedigrees of intellectual/artistic achievement, while others sought advice on the eugenic fitness of proposed marriages. Budding eugenics researchers convened at Cold Spring Harbor each summer to learn how to conduct field work—interviewing subjects, taking medical histories, and constructing pedigrees. During its years of operation, 1910–1939, the ERO amassed hundreds of thousands of family records, pedigrees, and articles on eugenics.

Eugenics arose during the progressive era that followed in the wake of the industrial revolution, when the fruits of science and technology were improving many aspects of life. A growing middle class of professional managers believed that scientific progress offered the possibility of rational cures for social ills. At the same time, eugenicists advanced the notion that bad genes lay at the root of age-old social problems, including poverty, crime, prostitution, and insanity. They warned that bad genes—especially those purportedly entering the country with immigrants from southern and eastern

Europe—threatened to pollute the predominately Anglo "foundation stock" of America. "Data" collected by eugenicists begged an obvious question: Why build more insane asylums, poorhouses, and prisons, when the underlying problem—bad genes—could be halted by controlling human reproduction? This progressive slant appealed to many educated Americans, who also accepted the Malthusian notion that the human species required some sort of pruning to maintain its health.

American eugenics was thus transformed, by degrees, from an agricultural experiment to a popular program in social engineering. Flawed eugenic data provided a supposedly scientific basis for social legislation to separate racial and ethnic groups, restrict immigration from southern and eastern Europe, and sterilize people considered "genetically unfit." The 1927 decision of the United States Supreme Court, Buck v. Bell, upheld the constitutionality of eugenic sterilization and signaled the nadir of American civil liberty. By the 1930s, the Nazis applauded the scientific use of eugenic sterilization and based their own sterilization laws on a model provided by the ERO's Harry Laughlin.

Although scientific opposition to eugenics mounted in the United States during the 1930s, it did little to dampen public enthusiasm. Many sophisticated geneticists, including some whose data refuted key eugenic tenets, were ambivalent and supported some type of eugenic program at one point or another. Only growing public knowledge of the Nazi's horrific "final solution" to achieve racial purity led to a wholesale abandonment of popular eugenics, and the ERO was closed in December 1939.

The eugenicists sought an exclusively genetic explanation of human development, neglecting the important contributions of the environment. They managed to inculcate this belief into a whole generation of educated Americans. This is perhaps the greatest danger of modern genetics—that genes once again will be misconstrued as the sole determinants of human life. Genetic determinism is implicit in the Human Genome Project's objective to identify genes involved in human health. The search for disease genes, prima facie, entails value judgments about what is normal versus abnormal. The social and legal acceptance of such judgments may create a pressure for genetic conformity that is difficult to predict today. What will it be like when we have a precise catalog of all the good, bad, and middling genes, and the wherewithal to determine who has which? In the face of such knowledge, will society continue to acquiesce to those who prefer to let nature take its course?

The real lesson of eugenics is that it was practiced by well-intentioned persons and bigots alike, and, short of the most obvious excesses, there was often no sharp line between them. Certainly forms of behavior that pass for eugenics are with us today. The killing fields of Cambodia, Central Africa, and the Balkans differ only in method and degree from the Nazi regime of "negative eugenics." Viewed in the cold light of racial and ethnic cleansings, it may seem clear to some that strict, and amoral, adherence to scientific data will protect us from future abuses of genetics. In this sense, the cleansing of the human genome of disease genes can be viewed as merely antiseptic. However, the past tells us that assumptions about human genetics are rarely value-neutral—many of the first crop of human geneticists loaded their data and models with their own aspirations for society.

Harry Laughlin and Charles Davenport outside the Eugenics Record Office (ERO). Image source Harry H. Laughlin Archives, Truman State University.

We chuckle at eugenicists' pedigrees of musical talent, lack of moral control, and criminal tendencies. Yet today, molecular geneticists are actively searching for genes involved in perfect pitch, sexual orientation, aggression, and other constructs of human behavior. Every parent's longing for healthy, happy children, who can continue the flow of their family heritage, is an expression of the best aspirations of "positive eugenics." In the context of in vitro fertilization, what parent wouldn't choose to implant the embryo whose gene combination favors intelligence and creativity? Therefore, rather than dismissing eugenics out of hand, it is far better that each of us attempts to discover where we, and the technologies that we are using, stand in its continuum. Then we can guard against slipping too far.

Launch of the Image Archive on the American Eugenics Movement

With these ideas in mind, in 1998 we embarked on a major project to collect archival materials on the American eugenics movement and publish them on the World Wide Web (WWW). On February 11, we launched the Image Archive on the American Eugenics Movement, as the second major content site at the DNALC's WWW Site. The project is funded by a grant from the Ethical, Legal, and Social Issues(ELSI) Program of the National Human Genome Research Institute.

With more than 1200 images and documents, the Eugenics Archive provides students, teachers, scholars, and the interested public with an extraordinary window into a "hidden" chapter of history. We hope that the opportunity to revisit this period will stimulate people to think critically about our current involvement in human genetics. By providing access to the eugenicists' own words and "data," we hope to challenge visitors to assume the role of historian/researcher. By focusing primarily on visual documents, we hope to engage young people and others who would not normally access a scholarly collection.

When we were conceptualizing the project, we wanted to develop a resource that could stimulate independent thinking about eugenics without espousing a "correct" interpretation of the materials. Although there was consensus that it is important to make the materials available for public scrutiny, there was also grave concern that they might be misinterpreted as "proven science" and therefore be misused to support racist views. Thus, we were challenged to assist users in understanding the historical, social, political, and ethical context in which the American eugenics movement developed, flourished, and finally collapsed. Context is built into the Archive on two levels. First, users are encouraged to enter the Site through a series of virtual exhibits, which introduce the key events, persons, and social conditions that contributed to the development of eugenics. Second, all images are sorted into more than 20 topic areas. Browsing by topic or searching by keyword returns a set of related images with extended captions. The topic captions are designed to help the user understand relationships among images and the relationship of the image to the eugenics movement and society. Both levels were developed in collaboration with several leading historians of eugenics. At each level, users are reminded that the vast majority of what was presented as scientific "fact" by eugenicists was fundamentally flawed and has been discredited by modern research standards.

The very act of publishing eugenic materials on the Internet set precedents for other projects dealing with the release of sensitive documents via the Internet. The documents were drawn from four major archives: the American Philosophical Society Library, Rockefeller University Archive Center, Truman State University Archives, and Cold Spring Harbor Laboratory Research Archives. At the start of the project, each archive had concerns about the large-scale publication of eugenic materials, and none had policies governing the release of their materials over the Internet. Thus, we were challenged to develop guidelines for online publication, educational "fair use" of documents, and privacy protections for subjects of the Archive. These policies were developed by consensus during 6 days of workshop sessions by a 15-member advisory panel:

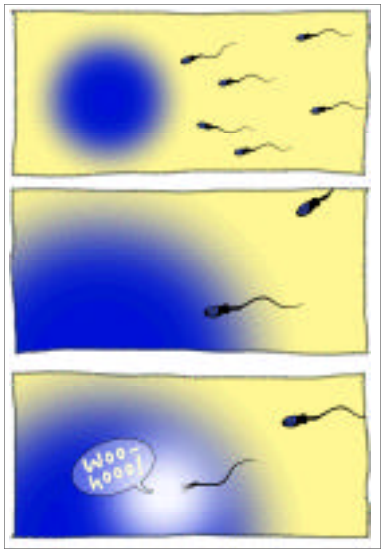
Garland Allen, Washington University, St. Louis, Missouri
Elof Carlson, SUNY, Stony Brook, New York
Pat Colbert-Cormier, Lafayette High School, Louisiana
Nancy Fisher, Regence Blue Cross, Seattle, Washington
Henry Friedlander, City University of New York, New York
Daniel Kevles, California Institute of Technology, Pasadena
Philip Kitcher, University of California, San Diego
Martin Levitt, American Philosophical Society, Philadelphia, Pennsylvania
Paul Lombardo, University of Virginia, Charlottesville
Nancy Press, Oregon Health Sciences University, Portland
Philip Reilly, Shriver Center for Mental Retardation, Waltham, Massachusetts
Pat Ryan, Carolina Biological Supply Company, Burlington, North Carolina
Marsha Saxton, World Institute on Disability, San Francisco, California
Steven Selden, University of Maryland, College Park
Terry Sharrer, National Museum of American History, Washington, D.C.

Completion of DNA from the Beginning

In the fall, we completed a 3-year project to publish an online "primer" on genetics, DNA from the Beginning (DNAFTB). Funded through a grant from the Josiah Macy, Jr. Foundation, DNAFTB is one of the most content-rich and innovative Web Sites on the WWW. Aimed at a high school audience, the Site is popular with genetics teachers, but also with regular folks who are interested in keeping up with today's news stories on cloning and genetic engineering. More than 750,000 people viewed DNAFTB in 2000, and it accounts for about 60% of the visits to the DNALC WWW Site. DNAFTB's media-rich elements were designed to operate over fast Internet connections (such as T1, cable modem, and DSL), so in 2001, we will offer a CD version that will play quickly in situations with slow, or no, Internet connectivity.

The 41 chapters cover concepts a person needs to know to understand what is going on in biology today, from Mendelian genetics to the structure of DNA to techniques used to make "knock-out" mice. Central to each chapter is an animation in which researchers describe how they did key experiments that contributed to understanding the concept. The animation helps viewers visualize molecular events and dynamic interactions that are difficult to portray in static diagrams. Video clips and a gallery of personal photographs bring home the fact that scientists are real people with whom anyone can identify. The work of more than 80 scientists is highlighted in animations and interviews, including 25 Nobel Laureates (*) and 11 past and present CSHL scientists (+):

Garland Allen
Oswald Avery
David Baltimore*
George Beadle*
Seymour Benzer
Michael Bishop*
Theodor Boveri
Herbert Boyer
Sydney Brenner
Roy Britten
Patrick Brown
Leigh Burgoyne
Mario Capecchi
Elof Carlson
Thomas Cech*
Erwin Chargaff
Stanley Cohen
Francis Collins
Carl Correns
Francis Crick*
James Darnell
Charles Davenport+
Igor Dawid
Hugo de Vries
Walther Flemming
Stephen Fodor
Rosalind Franklin
Raymond Gesteland
Walter Gilbert*
Doug Hanahan+
Leland Hartwell
Michael Hengartner+
Alfred Hershey*+
Dean Hewish
Mahlon Hoagland
Robert Horvitz
Francois Jacob*
Arthur Kornberg*
Roger Kornberg
Phil Leder
Joshua Lederberg*
Phoebus Levene
Edward Lewis*
Scott Lowe+
Maclyn McCarty
Barbara McClintock*+
Richard McCombie+
Gregor Mendel
Matthew Meselson
Freidrich Miescher
Stanley Miller
Jacques Monod*
Thomas Hunt Morgan*
Hermann Muller*
Marshall Nirenberg*
Christiane Nusslein-Volhard*
Robert Olby
Svante Paabo
Reginald Punnett
Richard Roberts*+
Stanley Rupert
Frederick Sanger*
Thomas Sargent
Brian Sauer
Theodor Schwann
Jane Setlow
Richard Setlow
Philip Sharp*
George Shull+
Frank Stahl
Nettie Stevens
Alfred Sturtevant
Howard Temin*
Harold Varmus*
J. Craig Venter
Erich von Tschermak-Seysenegg
Ivan Wallin
James Watson*+
Eric Wieschaus*
Michael Wigler+
Maurice Wilkins*
Paul Zamecnik



Postcards were mailed in spring and winter 2000 to promote DNA from the Beginning. The Uncle Darwin postcard was also used to solicit votes for the Webby Awards (discussed on the following page).

Webby Nominations and Renewed Funding for the BioMedia Group

The success of the DNALC's Internet publishing ventures was affirmed in April when members of the BioMedia group traveled to San Francisco to attend the 2000 Webby Awards, which are billed as the online Oscars. DNA from the Beginning was a finalist in the education category, and the DNALC portal site, Gene Almanac, was a finalist in the science category. We also received continuation funding for our two major content projects. Image Archive on the American Eugenics Movement received a 3-year continuation from the National Human Genome Research Institute, bringing five-year funding to $1,160,000. The Josiah Macy, Jr. Foundation approved a two-year continuation for DNA from the Beginning, bringing five-year contributions to $1,370,000. These renewals continue the BioMedia group's healthy financial situation and will allow us to be in full operation when we occupy our new BioMedia addition in 2001.

Macy funding will be used to develop Your Genes, Your Health (YGYH) as a companion to the existing site, DNA from the Beginning. YGYH will be a multimedia guide on genetic disorders for which causative genes have been identified and for which new diagnostics are available and rational treatments imminent. The site is specifically targeted at patients and families who are urgently looking for understandable information about a specific genetic disorder. These people are motivated to understand the meaning (the biology) behind the medical jargon they have read about or heard from a physician. The site will contain a number of resources that can help families participate more effectively in the care of a loved one:

- Animations to help visualize the unseen world of genes and molecules.
- Interviews with researchers and patients to provide insiders' perspectives on genetic disorders.
- Links to current news articles, support groups, and clinical trials to provide up-to-the-minute information on treatment options.

To make the site as responsive as possible to the needs of consumers, in December we convened a focus group of representatives from 10 genetic disorder foundations and support groups. We will continue to enlist the help of disorder-specific foundations and support groups to put us in touch with experts and families to interview for the WWW site and to review content prior to public release. By the end of the year, we were well on the way to producing the first module—on Fragile X Syndrome. By fall 2002, we expect to have published modules on 15 of the most common and most severe disorders for which genes have been identified (or are expected to be identified soon): Alzheimer, cystic fibrosis, Down syndrome, hemochromatosis, hemophilia, Huntington, Lou Gehrig, Marfan, muscular dystrophy, neurofibromatosis, Parkinson, phenylketonuria, sickle cell anemia, and Tay-Sachs.

VectorNet Portable Computer Laboratory

By year's end, we completed development of VectorNet, a portable computer laboratory designed as the centerpiece of a pre-college science education grant from the Howard Hughes Medical Institute. VectorNet was developed in response to problems we experienced conducting computer labs at institutions in the United States and abroad over several years, including lack of fast Internet service, local network unreliability, security provisions, nonuniform hardware setups, and software misconfigurations. The stand-alone system provides all computer hardware and software needed to deliver high-quality bioinformatics instruction at any location, regardless of existing computer infrastructure.

The VectorNet Laboratory consists of 12 participant notebook computers, network server-in-a-box, wireless router, wireless intranet transceivers, and video projector. The system can operate entirely from DNALC WWW Sites and Genbank subdatabases stored on the network server, or the router can provide centralized Internet access via a single T1, cable modem, or DSL connection. This equipment is packed in two wheeled containers, which can be shipped or carried as luggage to any site in the United States. Host institutions for VectorNet need only provide a classroom or seminar room with

tables, power points, and (optionally) a fast Internet line.

We also completed development of the key Internet resources that will be used in the program's student and teacher components: three Bioservers and the Genetics Origins meta-site. Allele Server allows students to tabulate student Alu insertion data and compare two populations by contingency chi-square, genetic drift, and genetic distance. Sequence Server allows students to compare DNA sequences through multiple sequence alignments and construction of phylogenetic trees. Both servers have facilities to allow students to enter their own polymorphism data and to compare their data with world reference populations. Simulation Server allows students to model genetic changes over time, simulating the same conditions in 100 or more test populations concurrently. Genetic Origins contains all resources to support student experiments with two polymorphisms—an Alu insertion and mitochondrial sequence variations. This "super site" includes laboratory protocols, reagent recipes, supporting animations, guided use of Bioservers, and video interviews with molecular anthropologists.

VectorNet functioned without major difficulties during the initial rotation at John F. Kennedy High School (Bronx), where 128 8th- and 9th-grade students used the portable lab to access the Image Archive on the American Eugenics Movement and DNA from the Beginning. The Allele Server was also used to analyze student DNA types for the Alu insertion polymorphism PV92. One teacher reported that working at the Allele Server site really helped students understand the difficult concept of genetic equilibrium in populations. Additional rotations for the 2000–2001 academic year have been planned in collaboration with the Gateway to Higher Education Program of Mt. Sinai School of Medicine and include the following schools: Benjamin Cardozo High School (Queens), Brooklyn Technical High School, Lafayette High School (Brooklyn), Life Sciences Secondary School (Manhattan), Queens Gateway to Health Sciences High School, Science Skill Center (Brooklyn), Bayard Rustin High School for the Humanities (Manhattan), and Stevenson High School (Bronx).

Initially, we had the entire setup returned for maintenance and server updating at the DNALC. However, in the future we intend to do most maintenance on site. Future rotations will be made easier by the purchase of a second server, which will allow us to provide each school with an up-to-date mirror of the DNALC WWW site. The equipment set will be transferred directly between schools. In a single visit to the receiving school, a DNALC staff member will swap the old server for an updated one, run equipment checks, and train participating staff.

During the next several academic years, the VectorNet Laboratory will continue to be rotated among New York City Public Schools. However, beginning in summer 2001, the VectorNet Laboratory will take on an additional life. During the summer, VectorNet will provide the infrastructure for administering week-long workshops on bioinformatics for biology teachers at sites held around the United States. In the 1980s and 1990s, the Vector DNA Science Workshop brought the methods of bacterial molecular genetics to teachers around the country. Now, the VectorNet Bioinformatics Workshop aims to help faculty extend their expertise to human molecular genetics and genomic biology.

We Prepare to Occupy a New Facility

Despite wet conditions during much of the summer, construction of the BioMedia addition progressed with amazing speed. The completion of this 8000-square-foot structure in spring 2001 will double the size of our facility and will provide the physical infrastructure needed to substantially increase the DNALC's impact on modern biology education.

By year's end, it was easy to visualize the future life of the new structure. The exterior brick façade and Georgian details blend perfectly with the existing building. One immediately grasps the cleverness of the design, which nestles the structure into the hillside such that the second-floor offices open directly onto the woody glade. Prominent on the lower level is the large space that will be occupied by a new teaching laboratory—directly in line with two other labs in our existing building. One can sense that the octagonal computer lab, centered on the main entrance to the addition, will become the symbolic heart of the building. This striking space, with two tiers of glass-countered work spaces, will emphasize that the business of understanding the trove of data from the Human Genome Project has, indeed, trans-

Clockwise from upper left: view of the BioMedia Addition from the west parking lot; the BioMedia Computer Laboratory; the genetics laboratory; and the suite of offices and conference area on the upper level. Images taken in December 2000.

formed biology into an information science. Like the best of today's genome biologists, students will have the opportunity to move effortlessly between biochemical manipulations of DNA and computer manipulations of the information stored in that DNA.

A large central gallery will nearly double the size of adjacent galleries in the existing building. Here, working in collaboration with curators from the American Museum of Natural History and the Smithsonian Institution, we will install entirely new exhibits on the Human Genome Project. A mini-DNA sequencing laboratory, where high school interns prepare and sequence DNA samples submitted from students around the country, will greet visitors entering this exhibition. One module will use the Old Order Amish as a case study—both of using distinct population groups to track down disease genes and as a metaphor for our rush into the "gene age." Although this anachronistic group appears to be stuck in the 19th century, they accept modern genetic medicine and are even preparing to participate in gene therapy trials. Another module will highlight CSHL's effort to sequence plant genomes: the model plant Arabidopsis and the important staple, rice. A module on the American eugenics movement, drawn from the evocative materials at our WWW site, will highlight lessons that can be learned from the misuse of genetics in the first part of the 20th century.

The entire upper level of the addition will be the home of the BioMedia group, our Internet publishing venture that focuses on providing authoritative, multimedia content on genetics. The loft-like space includes editorial offices and multimedia editing suites to support five major WWW sites in the DNALC portfolio. A video studio will allow us to expand into broadband communications and to further exploit CSHL's position as a gathering place for the world of molecular genetics. Here, we will interview leading scientists for use on our WWW sites and, potentially, for cable distribution.

We Become the First Science Center to Perform On-Site DNA Sequencing

During the past 2 years, we have developed a relatively simple system to allow students to obtain and work with their own DNA sequences. Using a kit developed by the DNALC and distributed by Carolina Biological Supply Company, students isolate DNA from hair roots or cheek cells, then mix their DNA with freeze-dried PCR reagents to amplify (enrich) a highly variable region of their mitochondrial genome. The amplified samples are then mailed to the DNALC, where high school interns perform the final DNA sequencing reactions.

The DNA sequences are placed in the Sequence Server database at our WWW Site, where they can be used to perform a number of analyses, including evolutionary comparisons with DNA from ancient humans and Neanderthals. The sequencer is currently set up on a Plexiglas-enclosed lab bench in our main exhibit hall, but will become a larger Visible Sequencing Laboratory as part of the major new exhibit on the Human Genome Project.

Initially, the actual sequencing was done in Dick McCombie's lab on the main campus, but in the spring we moved the sequencing to the DNALC. This was made possible by the gift of a new 377 DNA Sequencer, valued at $130,000, arranged by our good friend Frank Stephenson, head of technical training at Applied Biosystems. During the year, we processed 1140 samples submitted by 36 high schools, 15 universities/colleges, and 6 community colleges throughout the country. In addition, a switch to "big dye" chemistry substantially improved results. We are grateful for the help that we have received from the CSHL Genome Sequencing Center and Applied Biosystems, which has enabled us to prove the feasibility of providing a centralized sequencing facility for educational purposes.

In addition to our national program, we began offering DNA sequencing on the "menu" of lab field trips offered to students from local school districts. Students isolate and amplify their own mitochondrial DNA. After confirming polymerase chain reaction (PCR) success by electrophoresing samples in an agarose gel, students set up sequencing reactions using their own templates. Students and teachers are also introduced to the ABI 377 sequencer and to online sequence analysis tools available at the DNALC WWW site. After returning to school, the student samples are sequenced, and their sequence data are posted in the Sequence Server database.

During the year, we continued our collaboration with Rob DeSalle, head of the molecular biotechnology laboratory at the American Museum of Natural History in New York. Rob was curator of the highly successful exhibit "Outbreak" (1999) and is curator of the forthcoming exhibit, "The Genomic Revolution" (2001). With advice from the DNALC, Rob has included a teaching lab and DNA sequencer as integral parts of the exhibit. He plans to replicate our mitochondrial DNA sequencing program for field trips by New York City students visiting the museum's genome exhibit.

Instructional Programs Continue to Grow

The year proved to be a trying one for the DNALC staff. There was not a trace of unhappiness when mechanical preparations for the BioMedia addition necessitated moving everyone out of our dreary basement offices. We retasked exhibit space as a temporary office for the instructional staff, but there was no room at all for the BioMedia group, which ended up in very nice quarters in Williams House on the main CSHL campus. The retrenching of exhibit spaces and general overcrowding meant that overall visitation held steady at the 1999 level of 30,200. Miraculously, however, a record 21,750 students and teachers participated in hands-on labs and workshops.

During the spring, we wrapped up a successful workshop series sponsored by the Ethical, Legal, and Social Issues (ELSI) Program of the Department of Energy's Human Genome Initiative. The Science & Issues of Human DNA Polymorphisms introduced high school faculty to our hands-on experiments and computer software for the classroom analysis of human DNA. The final workshops were held at the Mailman Center for Child Development, University of Miami School of Medicine, and Austin Community College. During the summer, we concluded the National Science Foundation-sponsored program, Genomic Biology, with workshops held in Oklahoma, Utah, California, and New York.

Staff and Interns

Although several staff members departed during the year, there was a net growth of two positions in the DNALC staff in anticipation of expanded laboratory and Internet programs in the BioMedia addition.

In March, we were saddened to learn that Matt Christensen was leaving the BioMedia group to start a programming job in Chicago at unext.com. Matt was not just any programmer—he was a programmer with a passion for biology and bioinformatics. In addition to building our web site from scratch, he constructed a user-friendly interface for the bioinformatics tools that are found elsewhere on the Web but are tricky for high school students to navigate. Matt is currently enjoying the city life in Chicago, but his car has taken a beating in the 20-inch snow and 20-inch potholes.

Trish Maskiell (formerly Harrison) left us for New Hampshire when her husband got a new job. Trish started at the DNALC as a middle school teacher in 1997 and was promoted to Education Coordinator in 1998. Under Trish's management, enrollment in middle school programs increased and relationships with outside school districts solidified. Inside the classroom, Trish introduced the glowing genes lab and live C. elegans to young students. Kids loved Trish's mild-mannered teaching style and the analogies she came up with to help them understand genetics. Although she planned on becoming a stay-at-home mom in New Hampshire, rumors have it that she is back to coordinating, this time for a district-wide after-school program.

About the same time Trish left, we also said goodbye to Martha Mullally, a middle school teacher since 1998. Martha brought the middle school group her unique lab experience and successfully translated it for her students. One outside teacher said it best when she exclaimed, "I just love watching her teach! She's like a mad scientist!" Martha returned to her native Canada to start a 1-year education program at the University of Ottawa that will lead to a Canadian teaching certificate.

Veronique Bourdeau joined us in June to teach high school classes and develop new labs for the students. Vero recently received her Ph.D. in biochemistry from her hometown school, the University of Montreal, but grew up wanting to become a teacher. As luck would have it, her husband's work brought her to Cold Spring Harbor, and now she combines her research and teaching skills for us.

Two new middle school instructors also joined us this past summer, Elna Carrasco and Maureen Cowan. Elna knew she wanted an adventurous career in science after watching "Raiders of the Lost Ark." In love with the 70-foot Apatosaurus at the American Museum of Natural History since she was five, Elna searched for dinosaur fossils in Montana as part of her work for a degree in earth and space science from SUNY, Stony Brook. At the DNALC, she combines her interests in evolution and theater by performing/teaching the "Story of a Gene" to 5th through 8th graders.

Maureen Cowan had a teaching career in the back of her mind since high school, but it never really clicked until a friend complimented her presentation in a college genetics course. After graduating from Villanova in 1998 with a B.S. in biology, she came to Jerry Yin's lab at Cold Spring Harbor to study fruit fly behavior and worked at night on her master's degree in Secondary Education. Maureen brings her excitement about genetics into the classroom and is an excellent teacher.

"Jack-of-all-trades," Uwe Hilgert, joined the BioMedia group in November. Uwe (pronounced oov-eh) did his Ph.D. work at the Max-Planck Institute in Cologne, Germany, and post-doc work at the University of Arizona in Tucson. Engrossed with pathogenic fungi, Uwe was nevertheless drawn out of the lab one day to talk with an elementary school class, and the experience changed him forever. Since then, Uwe has helped develop science modules with teachers, taught molecular biology to senior citizens, and dabbled in the use of computers in teaching. At the DNALC, he is currently updating our bioinformatics tools and working with teachers to bring these tools to underprivileged schools in New York City.

Vin Torti joined us at the beginning of the year as the DNALC's own development officer. Vin spent 15 years teaching philosophy and raising money at Xaverian High School in Brooklyn before joining the development office at Cold Spring Harbor Laboratory. He enthusiastically combines his love of teaching with his love of raising money to make sure we can keep bringing the best genetics education to Long Island, New York City, and the world.

New employees, from left to right: Maureen Cowan, Uwe Hilgert, Elna Carrasco, and Veronique Bourdeau.

The DNALC's staff of high school interns continues to be a vital part of the daily "runnings" of the educational department. Interns prepare equipment and reagents for on-site and off-site lessons and, in the process, learn standard scientific techniques such as microbiological care and culturing, preparing and diluting solutions, restricting and ligating DNA, analyzing and sequencing DNA, and transforming cells. They experiment with many of the protocols when we reevaluate and upgrade the lessons. Currently, our veteran interns are Rebecca Shoer (Syosset High School), Caroline Lau (Syosset High School), Daniel Goldberg (Half Hollow Hills East High School), Yan Huang (Harborfields High School), and Janice Lee (Oyster Bay High School), and we welcomed newcomers Jordan Komisaro (Long Beach High School), Jared Winoker (Syosset High School), Benjamin Blond (Long Island School for the Gifted), and Marie Mizuno (Cold Spring Harbor High School).

After several years, many of our interns find their DNALC experience useful when they leave us for college or other jobs. Ken Mizuno, an intern for the past 2 years, headed for Carnegie Mellon University where he majors in computational biology and minors in computer science. Gina Conenello, an intern of 3 years, supervised the high school interns during the summer workshops and then left to attend Bucknell University, where she majors in biochemistry and cell biology. Greg Bautista left to attend Colgate University. Rebecca Yee, a Wellesley College student, returned during the summer to lead the middle school interns through the workshop season. Adam Frange (Wantagh High School) left his internship to begin an apprenticeship with Dr. Huifu Guo in CSHL's Beckman Laboratory.

In addition to their regular duties, many interns conduct independent research projects under the advisement of Scott Bronson. Caroline Lau and Daniel Goldberg received High Honors from the Long Island Science Congress for their research accomplished at the DNALC. Dan Goldberg's project focused on the effects of NF-1 genes in Drosophila melanogaster after heat shock response. Caroline Lau studied the population genetics of Long Island's native brook trout. Janice Lee is currently researching techniques in plant PCR. Rebecca Shoer is developing techniques in gene transfer of Hydra and Jordan Komisaro has already begun developing the tobacco mosaic virus as a classroom tool in plant research.

After 6 years, the DNALC said goodbye to Jermel Watkins. Jermel was head intern for many years, assisting instructors and interns alike. Presently, Jermel is working at SUNY, Stony Brook where he is investigating the genes associated with microglial activation in the brain when exposed to glutamate and LPS. We will miss him.

The BioMedia group continues to be extremely fortunate in their choice of high school and college interns. High school interns in 2000 were Tracy Mak, Syosset High School, and Felix Hu, Northport High School. The summer college interns were Sheila Vyas, Wellesley College, and Joshua Cohen, University of Washington.

PUBLICATIONS

Chan S., Yang C., Conova S. Lauter S., Christensen M., Witkowski J., and Micklos D. 1999–2000. DNA from the Beginning (http://vector.cshl.org/dnaftb/). DNA Learning Center, Cold Spring Harbor, New York.

Micklos D. and Carlson E. 2000. Engineering American society: The lesson of eugenics. Nat Rev. Genet. **1:** 153–158.

Mickos D., Lauter S., and Witkowski J. 2000. Image Archive on the American Eugenics Movement (http://vector.cshl.org/eugenics/). DNA Learning Center, Cold Spring Harbor, New York.

2000 Workshops, Meetings, and Collaborations

January 28–30	National Human Genome Research Institute ELSI Project, Eugenics Image Archive, Editorial Advisory Panel Meeting, Banbury Center
February 11	DNA from the Beginning interviews, Dr. Richard Setlow and Dr. Jane Setlow, Brookhaven National Laboratory
February 11	DNA from the Beginning interview, Dr. Elof Carlson, State University of New York, Stony Brook
February 17–20	American Association for the Advancement of Science Annual Meeting, Washington D.C.
February 27–March 2	Department of Energy Contractor-Grantee Meeting, Santa Fe, New Mexico
March 7	DNA from the Beginning interview, Dr. Richard McCombie, CSHL
March 16	Site visit by Steve Israel, Huntington Town Board Councilman, and Beverly Wayne, Institute on Holocaust and Law
	National Institute of Social Sciences Issues Discussion Group, New York, New York
March 20	Loomis Chaffee Convocation, Windsor, Connecticut
March 22	Huntington Township Chamber of Commerce Economic Summit II Meeting, Huntington, New York
	Gateway to Higher Education Planning Meeting, Mount Sinai School of Medicine, New York, New York
March 26–30	BIO2000 International Meeting & Exhibition, Boston, Massachusetts
March 29	National Human Genome Research Institute ELSI Review Panel, Bethesda, Maryland
March 31	Educational Advisory Board Meeting on the Human Genome Exhibit, American Museum of Natural History, New York, New York
April 3–5	Department of Energy ELSI Workshop, The Science and Issues of Human DNA Polymorphisms, The Mailman Center for Child Development, University of Miami School of Medicine, Florida
April 6	Laboratory for National Institute of Science, Beta Kappa Chi, Nashville, Tennessee
April 6–9	National Science Teachers Association Annual Meeting, Orlando, Florida
April 7–9	Department of Energy ELSI Workshop, The Science and Issues of Human DNA Polymorphisms, Austin Community College, Rio Grande Campus, Texas
April 11	Hutton House lecture, Long Island University, Brookville, New York
April 17	Great Moments in DNA Science Honors Students Seminar, CSHL
April 18	Hutton House lecture and laboratory, Long Island University, Brookville, New York
April 20	Site visit by Dr. June Osborn, Josiah Macy, Jr. Foundation, New York, New York and David Luke, Cold Spring Harbor Laboratory Board of Trustees
April 21	Seminar on Eugenics, Anne Arundel Community College, Arnold, Maryland
April 22	Laboratory for Rampart and Sierra High Schools, Colorado Springs, Colorado
April 25	Hutton House lecture, Long Island University, Brookville, New York
May 3	National Institute of Social Sciences Award Luncheon, Harvard Club, New York, New York
May 8	Great Moments in DNA Science Honors Students Seminar
May 11	Webby Awards, San Francisco, California
May 12	DNA from the Beginning interview, Dr. James Cleaver, University of California, San Francisco
May 12	DNA from the Beginning interview, Dr. Stanley Prusiner, University of California, San Francisco
May 22	Site visit by Carolyn Gusoff, Channel 4 News
May 22	Great Moments in DNA Science Honors Students Seminar
June 1	Site visit to Clinic for Special Children, Strasbourg, Pennsylvania
June 2	Site visit by Christopher Perez, Pfizer Foundation, New York, New York
June 5–10	National Science Foundation Workshop, Genomic Biology, Oklahoma City Community College, Oklahoma
June 16	Site visit by Frank Stephenson, Applied Biosystems, Foster City, California
June 19–24	National Science Foundation Workshop, Genomic Biology, Eccles Institute of Human Genetics, University of Utah, Salt Lake City
June 26-30	Fun With DNA Workshop, DNALC
	DNA Science Workshop, DNALC
June 26–July 7	Genomic Biology & PCR Minority Workshop, Central Islip High School, New York
June 28	Interview by Lea Tyrrell, Channel 12 News
June 30	Interview by Roland Pease, BBC worldwide
July 5	DNA from the Beginning interview, Dr. James Darnell, Rockefeller University, New York
July 10–15	National Science Foundation Workshop, Genomic Biology, California State University, Fullerton
July 10–15	Fun With DNA Minority Workshop, PS 38, Rosedale, New York
	World of Enzymes Workshop, DNALC
	DNA Science Minority Workshop, Brooklyn Technical High School, New York
	DNA Science Workshop, DNALC

July 17–21	Fun With DNA Workshop, DNALC
	DNA Science Minority Workshop, John F. Kennedy High School, Bronx, New York
July 17–22	National Science Foundation Workshop, Genomic Biology, DNALC
July 24–28	Fun With DNA Workshop, DNALC
	DNA Science Minority Workshop, Brooklyn Technical High School, New York
	DNA Science Workshop, DNALC
July 31–August 4	Fun With DNA Workshop, DNALC
	Genomic Biology & PCR Workshop, DNALC
August 4	Site visit by Alan Alda, Scientific American Frontiers
August 7–10	World of Enzymes Workshop, DNALC
	Green Genes Workshop, DNALC
August 14–18	Fun With DNA Workshop, DNALC
	DNA Science Workshop, DNALC
August 15	National Human Genome Research Institute ELSI Project, Eugenics Image Archive, collection visit to Museum of the City of New York
	National Human Genome Research Institute ELSI Project, Eugenics Image Archive, collection visit to American Museum of Natural History
August 21–25	Fun With DNA Workshop, DNALC
	Genetic Horizons Workshop, DNALC
	Genomic Biology & PCR Workshop, DNALC
August 28	Site visit by Dr. Nicholas Chiorazzi and Dr. Bette Steinberg, North Shore-Long Island Jewish Research Institute, Manhasset, New York
August 28–31	World of Enzymes Workshop, DNALC
	Green Genes Workshop, DNALC
September 7	Site visit by Rob DeSalle, American Museum of Natural History, New York, New York
September 9	Macmillan Genetics Encyclopedia Editorial Board Meeting, New York, New York
September 15	DNA from the Beginning interview, Dr. Michael Wigler, CSHL
September 18	DNA from the Beginning interview, Dr. Michael Hengartner, CSHL
September 19	Site visit by Dr. Frederick Volp, Cold Spring Harbor School District, New York
September 20	DNA from the Beginning interview, Dr. Eric Wieschaus, Princeton University, New Jersey
September 22	DNA from the Beginning interview, Dr. Scott Lowe, Cold Spring Harbor Laboratory, New York
September 24–25	American Association for the Advancement of Science–American Physiological Society Meeting, Warrenton, Virginia
September 28–29	National Human Genome Research Institute ELSI Project, Eugenics Image Archive, collection visit to State University of New York, Albany
October 3	Site visit by the Cosmopolitan Club, New York, New York
October 10–12	Howard Hughes Medical Institute Program Directors Meeting, Chevy Chase, Maryland
October 11	Site visit to Clemson University, Clemson, South Carolina
October 14–17	Association of Science–Technology Centers Conference, Cleveland, Ohio
October 16	Site visit by Philip Palmedo, Steven Barry, and Jerry Sandler, The Long Island Museum of Science & Technology, Garden City, New York
	Site visit by Stephen Speer, CSIRO Discovery, Canberra, Australia
October 25–28	National Association of Biology Teachers Annual Meeting, Orlando, Florida
October 27–28	National Science Foundation Program Directors Meeting, Washington D.C.
November 3–5	Department of Energy Meeting, Science Education on the Internet, Salt Lake City, Utah
November 7	Site visit to North Shore–Long Island Jewish Research Institute, Manhasset, New York
November 9	Howard Hughes Medical Institute City Genes meeting, CSHL
November 10	Site visit by Dr. Harold Cheatham and Dr. Jerry Trapnell, Clemson University, Clemson, South Carolina
November 13	EAB presentation, DNALC
November 21	Site visit to American Museum of Natural History, New York, New York
November 22	Site visit by Dr. John Reiher, The Center for Occupational Research and Development, Waco, Texas
November 29	Presentation for faculty and parents, Green Vale School, Glen Head, New York
December 4	National Institute of Social Sciences Gold Medal Award Dinner, Union Club, New York, New York
December 5	National Human Genome Research Institute ELSI Project, Eugenics Image Archive, collection visit to Ellis Island, New York
December 13	Site visit by Anne Dhanaraj, Singapore Science Centre
December 15	National Human Genome Research Institute ELSI Project, Your Genes, Your Health Planning Meeting, Banbury Center
December 19	DNA from the Beginning interview, Dr. Walter Gilbert, Harvard University, Cambridge, Massachusetts
December 21	Site visit by Lisa Darma and Lawrence Wallace, Carolina Biological Supply Company, Burlington, North Carolina

Sites of Major Faculty Workshops 1985–2000

Key: High School **College** Middle School

ALABAMA	University of Alabama, Tuscaloosa	1987–1990
ALASKA	University of Alaska, Fairbanks	1996
ARIZONA	Tuba City High School	1988
ARKANSAS	Henderson State University, Arkadelphia	1992
CALIFORNIA	**Foothill College, Los Altos Hills**	**1997**
	University of California, Davis	1986
	San Francisco State University	**1991**
	University of California, Northridge	**1993**
	Canada College, Redwood City	1997
	Pierce College, Los Angeles	**1998**
	California Lutheran University, Thousand Oaks	1999
	Laney College, Oakland	1999
	California State University, Fullerton	**2000**
COLORADO	Colorado College, Colorado Springs	1994
	United States Air Force Academy, Colorado Springs	**1995**
	University of Colorado, Denver	1998
CONNECTICUT	Choate Rosemary Hall, Wallingford	1987
DISTRICT OF COLUMBIA	**Howard University**	**1992,1996**
FLORIDA	North Miami Beach Senior High School	1991
	University of Western Florida, Pensacola	1991
	Armwood Senior High School, Tampa	1991
	University of Miami School of Medicine	2000
GEORGIA	Fernbank Science Center, Atlanta	1989
	Morehouse College, Atlanta	**1991,1996**
	Morehouse College, Atlanta	1997
HAWAII	Kamehameha Secondary School, Honolulu	1990
ILLINOIS	Argonne National Laboratory	1986,1987
	University of Chicago	**1992,1997**
INDIANA	Butler University, Indianapolis	1987
IDAHO	University of Idaho, Moscow	1994
IOWA	Drake University, Des Moines	1987
KANSAS	University of Kansas, Lawrence	1995
KENTUCKY	Murray State University	1988
	University of Kentucky, Lexington	1992
	Western Kentucky University, Bowling Green	1992
LOUISIANA	Jefferson Parish Public Schools, Harvey	1990
	John McDonogh High School, New Orleans	1993
MAINE	Bates College, Lewiston	1995
MARYLAND	Annapolis Senior High School	1989
	Frederick Cancer Research Center, Frederick	1995
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools	1990–1992
	St. John's College, Annapolis	1991
	University of Maryland, School of Medicine, Baltimore	**1999**
MASSACHUSETTS	Beverly High School	1986
	CityLab, Boston University School of Medicine	1997
	Dover-Sherborn High School, Dover	1989
	Randolph High School	1988
	Winsor School, Boston	1987
	Boston University	**1994,1996**
MICHIGAN	Athens High School, Troy	1989
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990,1991
MISSOURI	Washington University, St. Louis	1989
	Washington University, St. Louis	**1997**
NEW HAMPSHIRE	St. Paul's School, Concord	1986,1987
	New Hampshire Community Technical College, Portsmouth	**1999**
NEVADA	University of Nevada, Reno	1992
NEW YORK	Albany High School	1987
	Bronx High School of Science	1987
	Columbia University, New York	**1993**

	Cold Spring Harbor High School	1985,1987
	DeWitt Middle School, Ithaca	1991,1993
	DNA Learning Center	1988–1995
	DNA Learning Center	**1990,1992, 1995, 2000**
	DNA Learning Center	1990–1992
	Fostertown School, Newburgh	1991
	Huntington High School	1986
	Irvington High School	1986
	Junior High School 263, Brooklyn	1991
	Lindenhurst Junior High School	1991
	Mt. Sinai School of Medicine, New York	1997
	Orchard Park Junior High School	1991
	Plainview-Old Bethpage Middle School	1991
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–1990
	Titusville Middle School, Poughkeepsie	1991,1993
	Wheatley School, Old Westbury	1985
	U.S. Military Academy, West Point	**1996**
	Stuyvesant High School, New York	1998–1999
NORTH CAROLINA	North Carolina School of Science, Durham	1987
OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	North Westerville High School	1990
OKLAHOMA	School of Science and Mathematics, Oklahoma City	1994
	Oklahoma City Community College	**2000**
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy	1988
SOUTH CAROLINA	Medical University of South Carolina, Charleston	1988
	University of South Carolina, Columbia	1988
TEXAS	J.J. Pearce High School, Richardson	1990
	Langham Creek High School, Houston	1991
	Taft High School, San Antonio	1991
	Trinity University, San Antonio	**1994**
	University of Texas, Austin	**1999**
	Austin Community College-Rio Grande Campus	2000
UTAH	University of Utah, Salt Lake City	1993
	University of Utah, Salt Lake City	**1998**
	University of Utah, Salt Lake City	**2000**
VERMONT	University of Vermont, Burlington	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
WASHINGTON	**University of Washington, Seattle**	**1993,1998**
	Fred Hutchinson Cancer Research Center, Seattle	1999
WEST VIRGINIA	Bethany College	1989
WISCONSIN	Marquette University, Milwaukee	1986,1987
	University of Wisconsin, Madison	1988,1989
	Madison Area Technical College	**1999**
WYOMING	University of Wyoming, Laramie	1991
AUSTRALIA	Walter and Eliza Hall Institute and University of Melbourne	1996
CANADA	Red River Community College, Winnipeg, Manitoba	1989
ITALY	Porto Conte Research and Training Laboratories, Alghero	1993
	International Institute of Genetics and Biophysics, Naples	1996
PANAMA	**University of Panama, Panama City**	**1994**
PUERTO RICO	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
RUSSIA	Shemyakin Institute of Bioorganic Chemistry, Moscow	1991
SWEDEN	Kristineberg Marine Research Station, Fiskebackskil	1995

DNA LEARNING CENTER GRANTS AND PROGRAMS

Grantor	Program/Principal Investigator	Duration of Grant	2000 Funding+
FEDERAL GRANTS			
NATIONAL INSTITUTES OF HEALTH ELSI Research Program	Creation of a Digital Image Archive on the American Eugenics Movement	3/98–3/01	$ 201,289
NATIONAL SCIENCE FOUNDATION	A Partnership to Develop Advanced Technology Units on Genomic Biology	8/97–7/01	166,270
DEPARTMENT OF ENERGY	The Science and Issues of Human DNA Polymorphisms: An ELSI Training Program for High School Biology Teachers	1/97–9/01	62,642
NONFEDERAL GRANTS			
Howard Hughes Medical Institute	Precollege Science Education Initiative for Biomedical Research Institutions	7/94–8/01	66,732
Josiah Macy, Jr. Foundation	DNA from the Beginning	10/97–9/01	297,484

The following schools each awarded a grant for the Genetics as a Model for Whole Learning Program:

Bethpage Union Free School District	$ 1,050	Locust Valley Central School District	15,175
Commack Union Free School District	125	Mamaroneck Union Free School District	1,625
Community School District #29	33,375	Massapequa Union Free School District	1,425
East Meadow Union Free School District	4,065	Northport–East Northport Union Free School District	5,600
Farmingdale Union Free School District	1,995	Old Westbury School of the Holy Child	1,650
Garden City Public School	6,005	Oyster Bay–East Norwich Central School District	2,770
Great Neck Union Free School District	5,200	Plainedge Union Free School District	1,075
Green Vale School	2,800	Port Washington Union Free School District	6,770
Half Hollow Hills Central School District	6,375	Rockville Center Union Free School District	4,525
Harborfields Central School District	8,785	St. Dominic Elementary School	5,650
Jericho Union Free School District	5,500	Syosset Central School District	22,100
Lawrence Union Free School District	3,640		

The following schools each awarded a grant for Curriculum Study:

Commack Union Free School District	$1,100	Massapequa Union Free School District	2,200
East Woods School	1,100	Oceanside Union Free School District	1,100
Elwood Union Free School District	2,200	Oyster Bay–East Norwich Central School District	2,200
Friends Academy	2,200	Plainview–Old Bethpage Central School District	1,100
Garden City Union Free School District	1,100	Portledge School	1,100
Green Vale School	1,100	Port Washington Union Free School District	1,100
Half Hollow Hills Central School District	1,100	Ramaz School	2,200
Harborfields Central School District	1,100	Roslyn Union Free School District	1,100
Herricks Union Free School District	1,100	Sachem Central School District	1,100
Island Trees Union Free School District	1,100	South Huntington Union Free School District	1,100
Jericho Union Free School District	1,100	Syosset Central School District	1,100
Locust Valley Central School District	1,100	West Hempstead Union Free School District	1,100
Long Beach City School District	2,200		