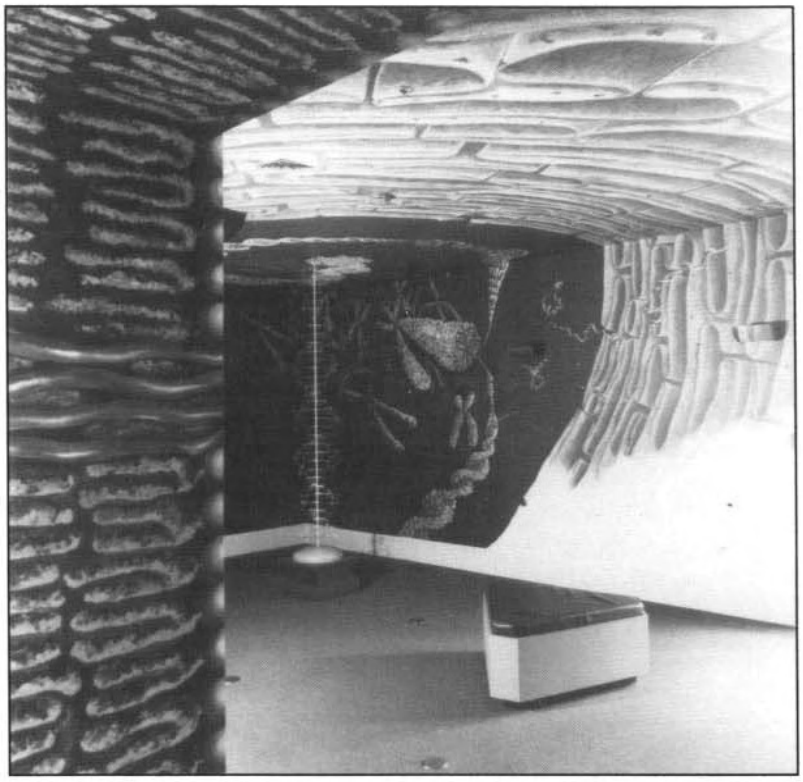
DNA Learning Center

Annual Report

1993



DNA Learning Center
Cold Spring Harbor Laboratory

One Bungtown Road
Cold Spring Harbor, New York 11724

Phone (516) 367-7240
Fax (516) 367-3043

DNA LEARNING CENTER

David A. Micklos, Director
Mark V. Bloom, Assistant Director
Susan M. Lauter, Designer
Jane P. Conigliaro, Education Manager
Diane S. Jedlicka, Laboratory Instructor
Diane Esposito, Laboratory Instructor
Flavio Della Seta, Laboratory Instructor
Judy L. Cumella, Administrative Assistant

Science museums and centers occupy an important position in American science education, providing "informal" learning opportunities that usually cannot be found within the formal school context. Science museums tend to accentuate technology and physical phenomena, which are amenable to hands-on exhibits that can stand up to use by large numbers of young people. With the exception of natural history, biology content is underrepresented, primarily because its subject matter does not translate well into interactive exhibits—living things by and large are not very amenable to manipulation by large numbers of students. Molecular genetics has proved a particularly difficult topic, because it deals almost entirely with phenomena that cannot be seen or manipulated in the usual sense. Our institution is unique in its focus on this difficult subject area. Our solution to the problem of dealing with things invisible has been to concentrate on providing high-level laboratories that help students learn about genes using the same modes of inference employed by research biologists. This emphasis on lab work places us in the company of a handful of science centers, notably the Lawrence Hall of Science, in Berkeley, California, and Fernbank Science Center, in Atlanta, Georgia.

Another unique attribute is our building, which was constructed in 1925 as Union Free School, the first "modern" elementary school in the village of Cold Spring Harbor. Designed by the noted New York architectural firm, Peabody, Wilson & Brown, the building's symmetrical brick facade and details, such as dentil moldings and quoins, echo the Georgian revival architecture popular among builders of Long Island's "Gold Coast" estates of the period. It is likely not coincidence that school board member and patron of construction of the building Jean Brown Jennings lived at the large Georgian-style estate "Burrwood" in nearby Lloyd Harbor with her husband Walter Jennings, a founder of Standard Oil Company. We think that Mrs. Jennings and others who were responsible for the construction of this beautiful building, as well as those who spent a good portion of their childhoods here, would be happy to see it preserved and tastefully updated as a showcase of modern science. In an architectural sense, the DNALC is truly a house of science, unlike most science centers, which typically strive to look futuristic. Many of these facilities are out of context with the architecture of their urban surroundings and appear unstuck in time, perhaps in a subtle way perpetuating the stereotype of science as an ivory tower out of touch with mainstream culture. We believe that our antique-style building sends the healthier message that science is forward looking, yet rooted in time and culture.

We Own a Completely Refurbished Facility

The DNALC has gone through several rounds of renovations, totaling $1.5 million, since we took lease of the facility from the Cold Spring Harbor Central School District in September 1987. Initial renovations in 1987–1989 included installing new heating/air-conditioning and electrical systems and converting a former classroom into the *Bio2000* Biochemistry Laboratory, the teacher's lounge into a bookstore, and the unfinished basement into staff offices and a research/prep laboratory. Other former classrooms, a library, and auditorium were converted into galleries in which were installed *The Search for Life*, a multimedia exhibit on the history of genetic technology loaned by the National Museum of American History.

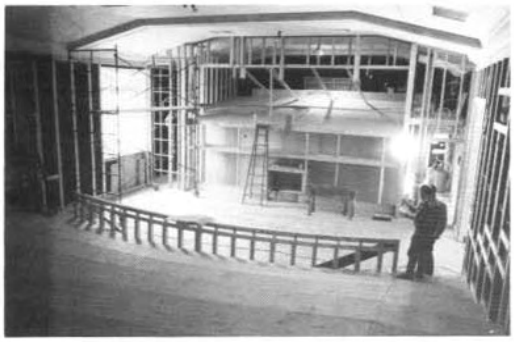
Bridge financing by the Banbury Fund and tax-exempt financing from the Nassau/Suffolk County Industrial Development Agency made possible the purchase of the DNALC property in January 1993. A concept design study funded by longtime friends Mary Jeanne and Henry Harris provided a guide for the redevelopment of the main floor and exterior of the building in 1993. Prior to beginning renovations in April was the arduous task of clearing the building of some 9000 cubic feet of exhibit materials and hardware from *The Search for Life* exhibit, including two tractor trailers of parts! Major entrances were rebuilt and automatic fire sprinklers were installed to bring the building into full compliance with all handicap access, fire, and safety codes. Three galleries were renovated for future exhibits on human genetics and research at Cold Spring Harbor Laboratory. A *BioMedia* Computing Laboratory, equipped with 13 Macintosh computers and video projection, was installed in renovated space adjacent to the existing *Bio2000* Biochemistry Laboratory. This project, as well as renovation of a

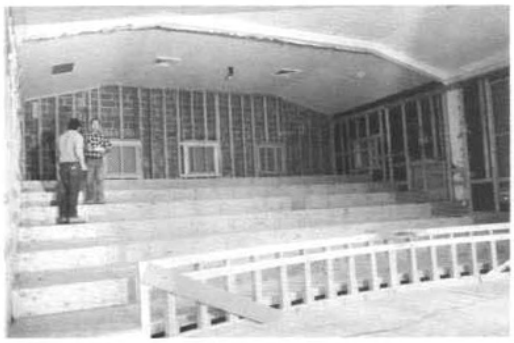
(*Left to right*) General contractor Bill Baldwin, DNALC Director David Micklos, CSHL Buildings and Grounds Director Jack Richards, and Centerbrook architect Jim Childress discuss renovation plans.

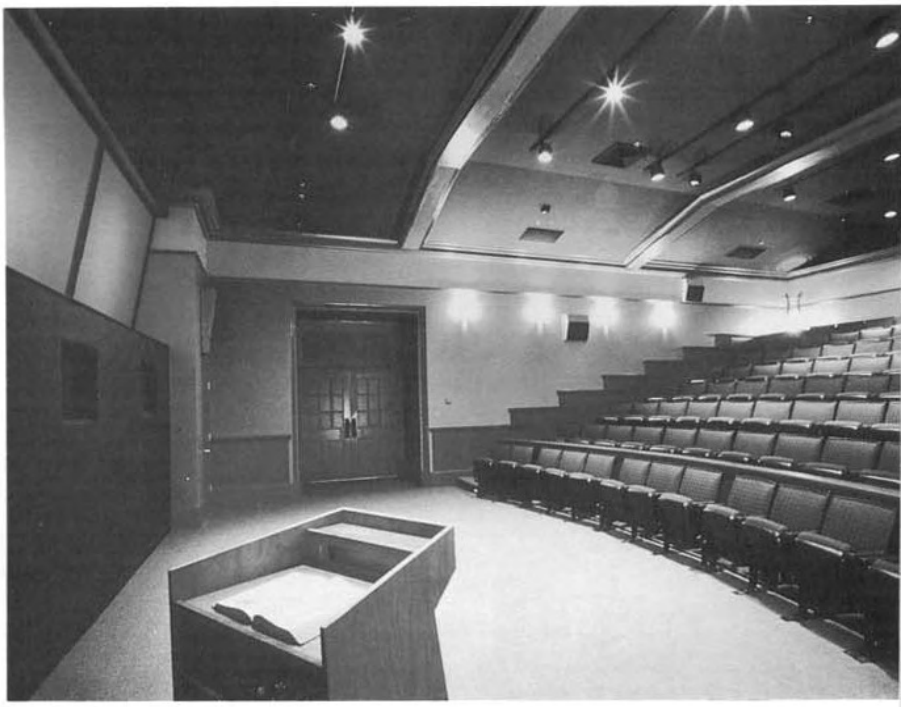
Demolition and reconstruction of front porch of DNALC.

(*Top*) Refurbishment of front hall. (*Bottom*) Cellarium under construction, during painting and set for Corporate Advisory dinner.

computation/design office in the last remaining undeveloped basement space (in 1994), will be the final phase in the development of the DNALC as a model Human Genome Education Center. Planned for 1995 is construction of a 3500-square-foot *BioMedia* addition to the south side of the building, which will include a genetics laboratory and research library. The addition will also include modern lavatory facilities and an atrium/lunchroom—practical features needed to effectively handle our growing numbers of student visitors.



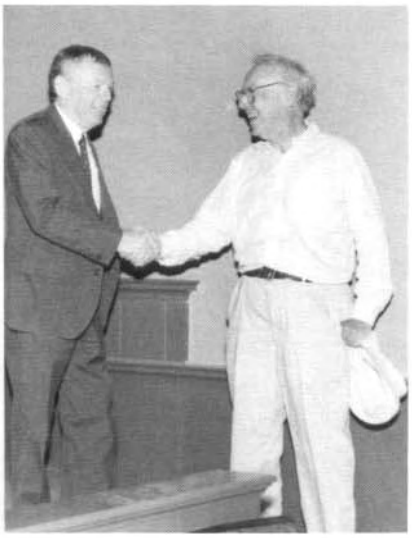




Multitorium under construction—looking toward screen area and rear-projection booth (*left top*), and before and after views of seat risers (*bottom* and *right*).

The 18 by 50-foot *Cellarium*, a room-size mural of the interior of a human cell, creates a splendid backdrop in the main gallery. This cell mural was completed during the summer by five art students from The Cooper Union for the Advancement of Science and Art (Hope Gangloff, Marius Jaskowski, and Jackie O'Neill) and the New York Institute of Technology (Donna Conversano and Elvia Reynolds), working under the direction of staff designer Susan Lauter. A 1/12th scale master drawing was divided into a 2 by 2-inch grid, and a corresponding 2 by 2-foot grid was chalked onto the ceiling and walls of the gallery. Each grid square on the master was scaled up on a 2-foot square of drafting tissue. Then, the back of each tissue drawing was rubbed with graphite and traced into its appropriate grid position in the gallery. The variety of colors seen in the mural were obtained by mixing only 12 colors of latex interior house paint. Twenty-five gallons of paint were applied using brushes and natural sea sponges.

The centerpiece of the renovation is a 104-seat multimedia auditorium, or *Multitorium*. The vaulted ceilings and plaster moldings of the original 1925 auditorium were preserved and complemented with a bold color scheme of blues, rust, and terra cotta. A frieze carries the names of 35 Nobel laureates who have contributed to our understanding of genetics and the molecular basis of heredity. Deeply banked seating provides a superb view for all, and the wide aisles provide a uncommon feeling of spaciousness. A remote control allows one to shift easily between all major types of visual presentation—video, laser disk, computer, compact disk, slides, and overhead/opaque projection. The audio system makes use of JBL power amplifiers and three-way JBL studio monitors, computerized feedback control, and wireless radio-frequency microphones.



Cablevision CEO Charles Dolan and CSHL President James Watson at a preview of *Long Island Discovery*

Long Island Discovery

The Multitorium is the venue for *Long Island Discovery*, which opened in September and received 6400 viewers during its first quarter of operation. This 28-minute "electronic field trip" was especially designed to help students explore the rich history of Long Island. Beginning with the mammoth glaciers that created the unique 118-mile-long landscape, the production presents a collage of the Long Islanders who shaped its history, including Indians, settlers, and whalers; Captain Kidd, the pirate; Anna Strong, the Revolutionary War spy; Jupiter Hammon, the first published African-American poet; Charles Lindbergh, the first trans-Atlantic aviator; and William Levitt, the architect of suburban living. The fast-paced presentation makes full use of the Multitorium's audiovisual capabilities. Thousands of images from 18 slide projectors and 3 video projectors are trained on three 5 by 7-foot glass screens and three 32-inch television monitors. Digital stereo surround sound is provided through ten JBL speakers, including an 18-inch sub-woofer.

Long Island Discovery was produced by Cablevision Systems Corporation, one of the nation's largest cable operators. The project was conceived by Charles Dolan, Cablevision Chairman/CEO and Cold Spring Harbor Laboratory Trustee, after seeing a similar presentation in Ireland. Charles recognized a fit between the DNALC's desire for a state-of-the-art auditorium and Cablevision's need for a dedicated facility to make its production widely available to local school children. Cablevision provided major funding for the renovation of the Multitorium and galleries, and the urgency to bring *Long Island Discovery* quickly to the public provided the impetus to complete construction in only 5 months+.

Renewal of National Science Foundation Support

The new year brought news of the renewal of key National Science Foundation (NSF) support of our training programs for high school and college faculty. A 3-year grant of $854,150 continues support for the *DNA Science Workshop* for high school teachers, which has received NSF funding since 1987. Through 1993, DNALC staff have instructed 1639 teachers at 74 workshops held in 31 states, Canada, and Puerto Rico. Building upon our past success, the new NSF program provides a two-tier model for organizing a critical mass of leadership teachers in molecular genetics at the national level and for disseminating genetics instruction at the local level. At the first level, *Targeted DNA Science Workshops* provide first-order training activity for underserved teachers and act as a screen for teachers with leadership potential. At the second level, the *Leadership Institute in Human and Molecular Genetics* provides recognition and super-order training for innovative leaders among the estimated 3500 high school teachers who have taken training workshops on molecular genetics/biotechnology. The aim is to utilize super-lead teachers as regional educational resources to ramify new teaching technologies in their regions and provide liaison between school systems and genetic information sources (such as genetic disease foundations/support groups and the National Institutes of Health). Following their training, lead teachers are pledged to provide a minimum of 30 hours in-service instruction for elementary and secondary teachers in their regions.

Our analysis of databases assembled by the National Academy of Science indicates that there are approximately 30 major, ongoing training programs for precollege teachers in genetics/biotechnology that are administered through

Leadership Institute participants (*left*) recreate a vintage photo of an early class at the Biological Laboratory (*right*, circa 1895).

academic institutions in the United States. However, most high-caliber institutes are offered in major urban centers of the east, midwest, and far west, thus effectively excluding rural and nonurban teachers in the south, midwest, southwest, Rocky Mountains, northwest, and Puerto Rico. Thus, the targeted workshops are designed to provide educational equity to underserved teachers in rural/nonurban areas by offering them the same high-quality instruction available to their urban peers. The first round of targeted workshops was held at John McDonogh High School in New Orleans and the University of Utah in Salt Lake City.

The Leadership Institute, held July 6–30, drew together 23 innovative teachers from 16 states. The participants' previous experiences included teaching advanced laboratory units in molecular genetics, leading teacher-training workshops, developing model curriculum materials, administering equipment-sharing consortia, and conducting a state-wide survey of biotechnology education. To build upon this expertise, the institute provided 160 hours of advanced laboratory experimentation, scientist seminars, computer explorations, leadership training, classroom observations, and independent projects. One highlight was an informal question-and-answer period with the Laboratory's Director James D. Watson, who shared the Nobel prize for the discovery of the structure of DNA. Others were "high-technology rotations" through the laboratories of Cold Spring Harbor scientists working in the technology-intensive areas of X-ray crystallography, protein biochemistry, and two-dimensional protein electrophoresis. Leadership teachers were free to attend seminars of three of the Laboratory's postgraduate training courses, which were scheduled concurrently. Leadership teachers were housed along with visiting scientists on the Laboratory's 100-acre campus. A summer stay at Cold Spring Harbor, and the chance to interact informally with staff and visiting scientists in residence, was a fitting honor for the leadership teachers, who represent the top 1% of high school biology instructors nationwide.

The continuation of our successful *Advanced DNA Science Workshop* for college faculty was assured upon renewal of our NSF grant, which provides $291,275 of support during the next 2 years. The workshop curriculum articulates with and extends that of the *DNA Science Workshop* to include more sophisticated techniques such as restriction mapping; Southern hybridization (nonradioactive); genomic library construction and analysis, cloning by polymerase chain reaction (PCR); and human DNA fingerprinting by PCR. The curriculum will be formally published in 1994 as *Laboratory DNA Science: An Introduction to Recombinant DNA Technology and Methods of Genome Analysis.*

During the summer, a pair of 2-week *Advanced DNA Science Workshops* were conducted at the University of Puerto Rico, Rio Piedras (July 26–August 6), and the University of Washington, Seattle (August 16–27). The program attracted 43 faculty from predominately teaching institutions in seven states and Puerto Rico. An additional 34 faculty from six different states were trained at a pair of workshops (Columbia University, May 24–June 1, and California State University, Northridge, June 14–25) sponsored by the Department of Education's Fund for the Improvement of Postsecondary Education.

Human Genome Diversity and Genetic Sensitivity

The rapid proliferation of screening tests to detect the genetic basis of human diseases ultimately may lead to social and legal judgments about what is genetically normal *versus* abnormal. Reducing predictive medicine to pinpointing often tiny genetic variances from the norm may also produce a mindset that overly focuses on the genetic differences between people. This runs counter to scientific evidence from the study of population genetics, which concludes that human beings are more alike genetically than they are different. Embodied in each person's genes is an unbroken flow of human evolution dating back millions of years. Noted human geneticist Luca Cavalli-Sforza has said that understanding the common ancestry of all human beings may be the best inoculation against racism for young people growing up in a world that increasingly emphasizes cultural, racial, and ethnic differences.

In addition to fostering formal genetic literacy, biology educators also will be faced with the task of turning out compassionate citizens who understand that, as Laboratory Director James Watson has said, "Some people get a bad start in life because they are born into poverty, and some people get a bad start in life because they are born with a bad set of genes." Most teachers attempt to stimulate this type of higher-order social and ethical analysis through case studies, role-playing, and panel discussion. Each of these methods essentially asks students to identify with an abstract situation largely removed from their own experiences. These methods often require a "briefing" of the "facts" of a case or technology, which can be substantially colored by the teacher's presentation or selection of materials.

As a remedy to this situation, we began in earnest in 1993 to develop plans for a *Human Genome Diversity–Student Allele Database* (HGD-SAD) project that will provide an experiment-based means for high school and college students to investigate human genome diversity. The project centers around a hands-on laboratory that enables students to produce a personal "DNA fingerprint" of the alleles (DNA variations) they have inherited on chromosome 1 (D1S80). Students then have the option of submitting their results to a *Student Allele Database*

maintained at the DNALC. Via computer, students can perform various statistical tests to compare their own alleles with those of students from around the United States and Europe. The exercise of making a personal DNA fingerprint and then comparing it to the fingerprints of other students challenges students to consider their place in the family of humankind, thus opening the door to genetic sensitivity. Students' questions about their own participation in the project engender much of the ethical and personal decision making of DNA typing and genetic data banking:

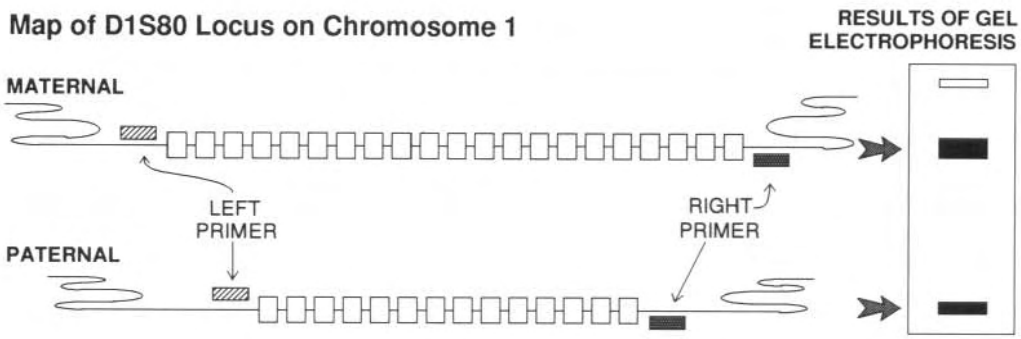
- Should I submit my alleles to the *Student Allele Database?*
- Does it matter if my anonymity is safeguarded?
- Are my alleles rare or frequent (in my class, in the world)?
- Do I share alleles with people of other races?
- Are the allele frequencies in my class different from those in other parts of the world?
- How genetically alike or different are people of (different countries, different races)?
- What if my DNA fingerprint was a diagnosis of disease susceptibility?

HGD-SAD also offers an example of the interdisciplinary nature of human genome research, which blends genetics, biochemistry, statistics, computational science, and social science. The commitment to map and sequence the human genome has called attention to the need for efficient computer strategies to collect, organize, store, and access the billions of nucleotides of DNA sequence to be generated over the next decade. HGD-SAD provides a simple analog of the growing use of computers in human genome research and illustrates a means to link together experimental and computer resources to encourage understanding of biological concepts. The project also provides an unprecedented opportunity for biology students and teachers to work in concert with genome researchers as they develop computational systems for genetic research.

The Student Allele Experiment

The student allele experiment is based on a forensic DNA typing kit optimized for educational use by DNALC staff member Mark Bloom. The object of the student allele experiment is to amplify and visualize a locus on the short arm of chromosome 1, termed D1S80, at which varying numbers of copies of a repeated DNA sequence create polymorphisms. These variable numbers of tandem repeats (VNTRs) are inherited in a Mendelian fashion as distinguishable alleles. The VNTR polymorphism at D1S80 has a repeat unit of 16 base pairs and displays 29 alleles that determine 435 possible genotypes. The size of a D1S80 allele depends on the number of VNTR copies present on the chromosome 1 inherited from the mother or father. For example, the maternally inherited allele may have 21 copies of the repeat unit, whereas the paternally inherited allele may have 14 copies. These different alleles can be separated by size using electrophoresis.

The experiment consists of three parts: sample isolation, amplification by PCR, and analysis by polyacrylamide gel electrophoresis (PAGE). Participating schools receive a kit that contains two simple reagents (sterile saline and 10% Chelex) and supplies for a class of students to prepare DNA extracts from their own cells. Students obtain cheek epithelial cells by a 10-second rinse with saline

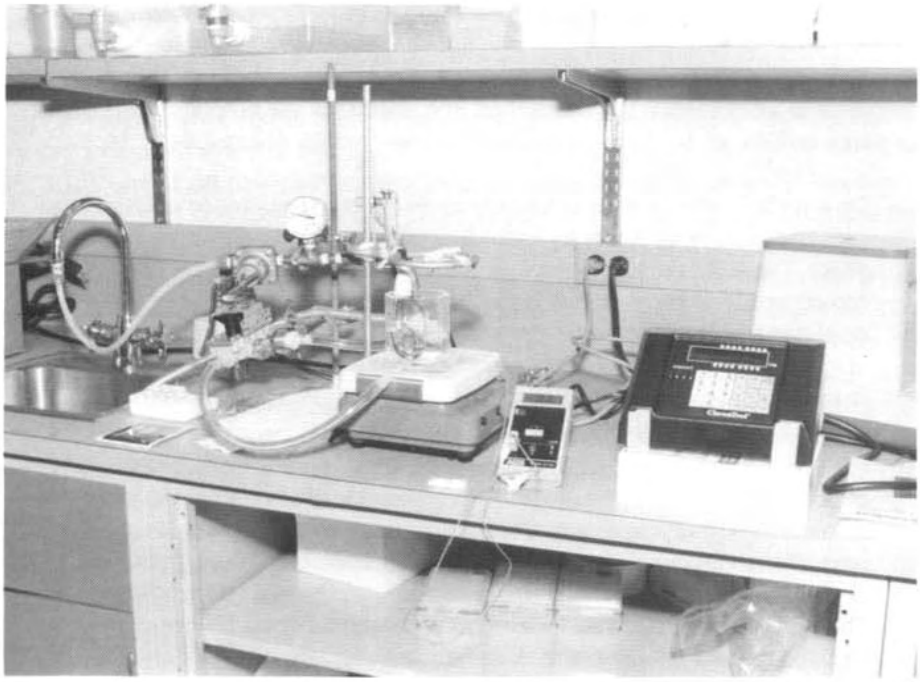


mouthwash *(bloodless and noninvasive).* Incubation at boiling temperature lyses the cheek cells and releases the DNA into solution. Cellular debris is separated from the crude DNA extract by centrifugation with Chelex, a chelating agent that binds inhibitors of the PCR.

The student DNA samples, identified only by number, are then passed on to a partner institution for PCR amplification and allele separation. A sample of this crude DNA extract is added to a "cocktail" of amplification reagents, including *Taq* polymerase, the four nucleotide phosphates, magnesium, and primers that identify the D1S80 locus on chromosome 1. Polymerase chain reaction is used to amplify the D1S80 locus of each student sample, and the amplification products are electrophoresed on a polyacrylamide gel, together with an allelic ladder of 27 amplified D1S80 alleles. A photostat of the stained gel is then provided to the participating teacher. Comparison of bands present in each lane with the allelic ladder allows students to determine their own D1S80 genotypes. Students have the choice of submitting their genotypes and demographic information, without personal identifiers, to the *Student Allele Database.*

HGD-SAD offers an appropriate point of collaboration for high schools and genome research centers. Electrophoretic analysis of human alleles is the next logical step for the growing numbers of high school biology teachers who are conversant in modern molecular genetics and currently perform electrophoretic analysis of viral DNA with their students. Preparation of student DNA samples requires only a clinical centrifuge and hotplate, which are available at most high schools or can be borrowed from a partner genome research center. Although the equipment needed for human allele detection—a DNA thermal cycler and polyacrylamide electrophoresis apparatus—is currently beyond the means of even the most advanced high school teachers, it is commonplace in any genome research center. A several hour commitment by a technical staff member at a genome research center is all that is required to generate the student genotypes.

Several options are open to high school teachers who would like to do more in-class experimentation. Amplified alleles can be separated in agarose using mini-gel apparatuses common in high schools. Although agarose systems can differentiate a number of alleles, they do not offer resolution great enough to score alleles for submission to the archival portion of the *Student Allele Database.* Efficient amplification of D1S80 alleles from crude extracts requires an automated DNA thermal cycler, the least expensive of which now costs approximately $2800. Therefore, we are working with the biocomputing center at the University of Chicago to develop a "washing machine" thermal cycler that will provide a low-cost alternative for amplifying student samples. Working from a design used in early efforts to automate thermal cycling at Cetus Corporation, teachers



Washing machine thermal cycler built by leadership teachers successfully amplified human DNA polymorphisms.

at the 1993 Leadership Institute built a prototype machine, essentially composed of a washer valve and plumbing supplies, that successfully amplified the D1S80 alleles. We are currently working with the University of Chicago biocomputing center to construct a computer controller that can be distributed with a ready-to-assemble kit.

With funds from the Stone Foundation, we have equipped a *Student Allele Reference Laboratory* to qualify all allele submissions to the archival *Student Allele Database*. The reference laboratory will also process student samples referred from teachers in rural and nonurban areas nationwide who lack a nearby partner institution. The laboratory is equipped for large-format PAGE and a computerized documentation system that allows submitted students' gels to be automatically read and digitized for archival storage. Tom White, Vice President of Research & Development of Roche Molecular Systems, has agreed to donate 750 PCR reactions and provide 750 reactions at a reduced price each year over the next 5 years to support the reference laboratory and activities to "seed" the project in different regions of the country.

The Student Allele Database

The *Student Allele Database* program software is being jointly developed here and in collaboration with Helen Donis-Keller at Washington University and John Kruper at the University of Chicago. Program software will be developed to run on three platforms: Macintosh, UNIX, and MS-DOS. Initial applications are being developed to run on Macintosh computers, which are common in high schools, followed by DOS/MS Windows versions. Several applications that will be part of

the package have already been developed in the Donis-Keller laboratory for use in a UNIX environment, which is common in genome research centers. These utilities will be the starting points for designing a robust and scalable client-server application to administrate SAD materials. The database will be composed of four major utilities, all of which make use of a user-friendly graphical interface:

- On the client side, a Public Data Utility (PDU) is accessible to all users and provides data entry forms for recording allele data and demographic identifiers. The PDU also provides a workspace where data can be temporarily stored and evaluated, or compared to data stored in the archive. The PDU operates both in "stand-alone" mode (allowing entry, display, and analysis of local data) and in a "networked client" mode (allowing data submission to the archived dataset and comparison of local data to archival data).
- On the server side, an Archival Data Utility (ADU) is accessed through the PDU on a "read only" basis for users. The archival database contains submitted student cases that have been refereed to meet standards for scientific use and incorporates relational database technology to allow fast and efficient processing of simultaneous queries. The ADU can be accessed by the system administrator to enter and/or edit refereed cases. The ADU incorporates key features of research databases, including scalability, data integrity, and disaster recovery.
- A Statistics Utility is accessible to all users to enable data analysis using files from the PDU and ADU. A number of statistical and graphical tools will be added over time, including allele frequency estimation, heterozygosity and polymorphic information content (PIC), Hardy-Weinberg equilibrium, single allele isoclines, analysis of variance, and genetic distance.
- A Bulletin Board is accessible to all users, allowing students and teachers to share findings, interpretations, lesson plans, and curricular materials. In addition, the Bulletin Board operates an Internet Relay Chat (IRC) system to provide interactive dialogue between participants. With this, teachers and students can discuss in real time their local efforts and ask questions of designated professor "mentors" (drawn from the partner regional genome research centers) during scheduled on-line "seminars."
- The Bulletin Board and Archival Data Utility reside on a Sun Sparcstation 10-30 server with one gigabyte SSCI disk storage currently available at the DNALC. A fiber optic line will link the DNALC to the main Laboratory campus, providing high-speed access to national and international networks. Partner research institutions here and abroad will likely prefer to access the database through Internet. However, secondary biology teachers will likely tie into the system via *Access Excellence,* a biology education network that is reached through America Online.

International Collaborations

Although human genome diversity is not a large element of the Human Genome Initiatives of the National Institutes of Health and the Department of Energy, it is an important component of research funded by the international Human Genome Organization (HUGO). Our Italian collaborator, Marcello Siniscalco is active in the HUGO project, and his institution, Porto Conte Research and Training Laboratories (PCRTL) in Sardinia, has been the site of planning workshops for the HUGO-sponsored project, *The People of Europe.* As a reference laboratory in the

HUGO genome diversity project, PCRTL maintains a high-speed Internet connection. Thus, it was appropriate that Dr. Siniscalco agreed that PCRTL will serve as the European node for the *Human Genome Diversity–Student Allele Database,* (HGD-SAD), mirroring the SAD on its system and qualifying European submissions to the archival database.

To cement the new collaboration, a pilot Human Genome Diversity Training Workshop was conducted at the PCRTL as part of the European Week of Science in November. Funded by the Italian Ministry of University and Scientific and Technological Research, the workshop built upon previous DNALC collaborations with PCRTL to develop activities for the Italian Week of Science in 1991 and 1992. The pilot workshop was attended by 19 secondary science teachers (representing 11 European countries) who produced their own D1S80 fingerprints and tested a new method of preparing DNA from saliva. Highlights of the workshop were talks by Luca Cavalli-Sforza and Alberto Piazza, both authorities on human genetic diversity. They showed the participants methods for analysis of genetic distance using D1S80 data from Asian Indians, American Blacks, American Caucasians, and Sardinian school students (obtained by Dr. Siniscalco's group). Several alleles were found among the Sardinian students that had never been seen among sample populations in North America.

Local Activities and Training Workshops

The *Bio2000* Laboratory was kept very busy during the academic year, with 3200 precollege students participating in lab field trips on Variability and Inheritance; Corn Genetics and Mendelian Inheritance; Cells, Chromosomes, and Mutations; DNA Structure and Recombination; Bacterial Transformation; DNA Restriction Analysis; and Human DNA Fingerprinting. The *Great Moments in DNA Science* Lecture Series, held in the spring, continued as a popular element of our annual calendar of events, drawing the attendance of 730 local students and teachers:

Michael Gilman, Cold Spring Harbor Laboratory: To Grow or Not to Grow—How a Cell Decides.

Seth Grant, Columbia University: How Do Genes Control the Way the Brain Stores Memories?

William Lennarz, SUNY at Stony Brook: Sperm Meets Egg.

David Micklos, Cold Spring Harbor Laboratory: Eugenics—From Science to Social Quackery.

In February, we conducted the final in a series of four *Human Genetics and Genome Analysis* Workshops funded by the Department of Energy. This program draws together opinion leaders and policy makers who must help society make sense and proper use of genetic technology. The program has provided an opportunity to formalize the existing strong ties between the DNALC and our sister organization, Banbury Center. The combination of high-level seminars and collegial exchange in beautiful surroundings at Banbury and hands-on labs at the DNALC has proven a winning formula for our bright, but nonscientist, clientele of government administrators, lawyers, ethicists, reporters, educators, and members of patient support groups. Jan Witkowski's keen scientific insight and broad contacts in basic/clinical molecular genetics ensure an extremely high caliber of featured speakers from around the country.

Kenneth Culver, National Institutes of Health: The First Human Gene Therapy Trials.

Neil Holtzman, John Hopkins Medical Institute: Map or Maze—The Future of Human Genetics.

Marsha Saxton, Massachusetts Office on Disability: Genetics and Cultural Attitudes to Disability.

Patricia Ward, Baylor College of Medicine: DNA-based Diagnosis for Human Genetic Diseases.

Barbara Weber, University of Michigan: Breast Cancer Genetics—Moving from Research to Practice.

Our summer workshop schedule took on added intensity with the addition of the month-long *Leadership Institute* for 23 high school faculty, as well as increased offerings for precollege students. Summer has traditionally been our

Corporate Advisory Board open house: Middle school student Matthew Bentz explains DNA extraction experiment. DNALC intern Chris Como demonstrates the *Genetic Computer Arcade* to his parents, Judy and Tom.

season for teacher-training workshops, and Mark Bloom continued his hectic schedule of four 2-week *Advanced DNA Science Workshops*, reaching 79 college faculty at workshops held in New York, Seattle, Los Angeles, and San Juan. Dave Micklos instructed a lightened load of *DNA Science Workshops*, reaching 67 high school faculty at workshops in New Orleans, Salt Lake City, and the DNALC. Demand for student spaces in the two local *DNA Science Workshops* has been increasing over the last several years, with 37 high-ability students participating in summer 1993. Seventy-eight minority/disadvantaged students (5–6th grade) were instructed, free of charge, at four *Fun With DNA Workshops* taught by Robert Willis at the DNALC and A. Phillip Randolph High School in Harlem. To satisfy the high demand for our "kiddie camps," we entered into a new collaboration to administer five *"Fun With DNA"* camps at Portledge School in Locust Valley. This arrangement allowed us to accommodate an additional 101 5–6th grade students. In addition, 23 7–8th graders attended the pilot of the new *World of Enzymes Workshop*, designed for past "graduates" of *Fun With DNA*.

Corporate Advisory Board

Under the strong leadership of Doug Fox, Vice President of Marketing for the Times Mirror newspaper group, the Corporate Advisory Board has risen to the challenge of increasing unrestricted annual support from the Long Island business community. In 1993, the Board raised a total of $66,650. Corporate Advisory Board members help explain the DNALC's role as a center of educational excellence and key element of the community infrastructure to support high-technology industry on Long Island. Board members are drawn from a gamut of Long Island businesses, including communications, banking, accounting, insurance, law, real estate, retail sales, and health care/biotechnology. Guiding the effort, and working closely with DNALC and Laboratory staff, are members of the executive committee:

Douglas B. Fox, Chairman

Rocco S. Barrese, Dilworth and Barrese
Thomas J. Calabrese, NYNEX
Gary E. Frashier, Oncogene Science, Inc.
Patricia Peterson, Dale Gale Agency
Paul A. Vermylen, Jr., Meenan Oil Company

Michael Aboff
Howard M. Blankman
Harry G. Charlston
Richard M. Clark
Kenneth Daley
Robert E. Diller
Mrs. Sinclair Hatch
Aurther D. Herman
John J. Lack
Ralf Lange
Mrs. Lilo Leeds
Ms. Shelia Mahony
Glenn Prestwich, Ph.D.
Francis Roberts, Ph.D.
Peter G. Schiff
John Smith
Michael Vittorio
Lawrence Waldman

Staff and Interns

We were disappointed when Robert Willis left his position as Special Programs Manager at the end of the summer to return to a teaching position in Maryland. Robert helped to expand our programs for minority and disadvantaged students in the New York metropolitan area, a task to which we remain committed. The vacuum created by Robert's departure was filled ably and cost-effectively by

three part-time laboratory instructors: Diane Jedlicka of Roslyn Public Schools and Drs. Diane Esposito and Flavio Della Seta, who have research positions at Cold Spring Harbor Laboratory. With degrees in elementary and special education, Diane Jedlicka administers the Roslyn OMNI Gifted Program with DNALC Education Manager Jane Conigliaro. Diane Esposito is a staff associate in the laboratory of Michael Wigler and has had research experience at Columbia University, Memorial Sloan-Kettering Cancer Institute, and North Shore Community Hospital. Diane also brings strong ties to our Italian collaborator Marcello Siniscalco, with whom she worked for several years. A native of Italy, Flavio is a postdoctoral fellow in the laboratory of Kim Arndt. Flavio has research experience in DNA structure and transcription at the University of Rome, University of Paris, and University of Nancy, where he holds a faculty position. We also rely on the collaboration of Twana Adams, an energetic minority educator with strong ties to community action groups in Harlem.

We were further frustrated when Administrative Assistant Sandra Ordway left at the end of the year to accept a position at the law firm Scheine, Fusco, Brandenstein, and Rada. Sandy first came to the DNALC in 1988 to organize a corps of neighborhood volunteers, joining the staff in 1989 to orchestrate our increasingly complex schedule of visiting schools and off-site workshops. We moved quickly to hire new Administrative Assistant Judy Cumella, who was a purchasing agent at Medical Sterilization, Inc. Additional administrative help was provided by part-time employee Margot Kohler and volunteer Katya Davey.

We continued to get excellent laboratory, computational, and administrative support from our growing staff of student interns drawn from neighboring school districts. Mark Staudinger, of Cold Spring Harbor High School, assisted Mark Bloom with *Advanced DNA Science Workshops* in Los Angeles, Seattle, and San Juan prior to beginning his freshman year at Muhlenberg College. Cold Spring Harbor senior David Hollman focused primarily on the development of multimedia computer programs and assisted Leadership Institute participants with computer projects, leaving at the end of summer for his freshman year in the College of Engineering at Cornell University. Ken Bassett, of Massapequa High School, assisted Dave Micklos with the *DNA Science Workshop* in Salt Lake City and assumed the position of senior intern at the beginning of the 1993–1994 school year. Assisting at *Fun With DNA* summer camps were lab aides Tara Marathe of Colby College, Daryn Berger of Walt Whitman High School, Andrea Conigliaro of St. Anthony's High School, and Michael Conigliaro of Cold Spring Harbor High School. New interns were Jessica Hinton of Huntington High School, Chris Como of Cold Spring Harbor High School, and Andy Diller of Sachem High School. Andy brought with him considerable lab experience and represents the fruition of our efforts to stimulate advanced biology instruction on Long Island. He had the opportunity to take two molecular genetics electives at Sachem, where instructor Fred Gillam runs the nation's largest precollege program in laboratory molecular genetics. Andy's father Bob is a member of the DNALC's Corporate Advisory Board and as Vice President of Marketing for Brinkmann Instruments has been instrumental in obtaining many gifts of Eppendorf pipets and centrifuges.

PUBLICATIONS

Bloom, M., G. Freyer, and D. Micklos. 1994. *Laboratory DNA Science: An Introduction to Recombinant DNA Technology and Methods of Genome Analysis.* (In press.)

Micklos, D. 1994. Genetic Testing: An Educational Imperative to Our Schools. In *Proceedings of the Committee on Assessing Genetic Risks, Institute of Medicine.* (In press.)

DNA LEARNING CENTER

Grantor	*Program/Principal Investigator*	*Duration of Grant*	*1993 Funding+*
FEDERAL GRANTS			
NATIONAL SCIENCE FOUNDATION			
	Middle School Faculty Enhancement	1990-1993	80,430
	High School Faculty Enhancement	1990-1993	25,254
	High School Faculty Enhancement	1993-1996	281,607*
	College Faculty Enhancement	1991-1993	47,169
	College Faculty Enhancement	1993-1995	97,092*
U.S. DEPARTMENT OF EDUCATION			
	College Faculty Enhancement	1991-1993	75,282
NONFEDERAL GRANTS			
Barker Welfare Foundation	Minority Programs	1992-1993	5,000
William Randolph Hearst Foundation	Middle School Program	1991-1994	15,927
Howard Hughes Medical Institute	High School Faculty Enhancement	1990-1993	8,926
New York State Legislature	Middle School Program	1993	50,000
Stone Foundation	Equipment	1991-1994	83,333
Commack Union Free School District	Genetics as Whole Learning Program	1993	5,000*
Great Neck Public Schools	Genetics as Whole Learning Program	1993	5,000*
Half Hollow Hills Central School District	Genetics as Whole Learning Program	1993	5,000*
Locust Valley Central School District	Genetics as Whole Learning Program	1993	5,000*
Plainedge Union Free School District	Genetics as Whole Learning Program	1993	5,000*
Commack Union Free School District	Curriculum Study	1993	850*
East Williston Union Free School District	Curriculum Study	1993	850*
Elwood Union Free School District	Curriculum Study	1993	850*
Garden City Union Free School District	Curriculum Study	1993	850*
Great Neck Public Schools	Curriculum Study	1993	850*
Half Hollow Hills Central School District	Curriculum Study	1993	850*
Harborfields Central School District	Curriculum Study	1993	850*
Herricks Union Free School District	Curriculum Study	1993	850*
Island Trees Union Free School District	Curriculum Study	1993	850*
Jericho Union Free School District	Curriculum Study	1993	850*
Kings Park Central School District	Curriculum Study	1993	850*
Lawrence Union Free School District	Curriculum Study	1993	850*
Lindenhurst Union Free School District	Curriculum Study	1993	850*
Locust Valley Central School District	Curriculum Study	1993	850*
Manhasset Union Free School District	Curriculum Study	1993	850*
Massapequa Union Free School District	Curriculum Study	1993	850*
Northport-East Northport Union Free School District	Curriculum Study	1993	850*
North Shore Central School District	Curriculum Study	1993	850*
Oyster Bay-East Norwich Central School District	Curriculum Study	1993	850*
Plainedge Union Free School District	Curriculum Study	1993	850*
Plainview-Old Bethpage Central School District	Curriculum Study	1993	850*
Portledge School	Curriculum Study	1993	850*
Port Washington Union Free School District	Curriculum Study	1993	850*
Roslyn Public Schools	Curriculum Study	1993	850*
Sachem Central School District	Curriculum Study	1993	850*
South Huntington Union Free School District	Curriculum Study	1993	850*
Syosset Central School District	Curriculum Study	1993	850*

* New Grants Awarded in 1993

\+ Includes direct and indirect cost

1993 Workshops, Meetings, and Collaborations

January 9–10	National Science Foundation Follow-up Workshop, *DNA Science,* University of Nevada, Reno, Nevada
January 16–17	National Science Foundation Follow-up Workshop, *Advanced DNA Science,* University of Puerto Rico, Mayaguez, Puerto Rico
January 23–24	National Science Foundation Follow-up Workshop, *DNA Science,* University of Puerto Rico, Mayaguez, Puerto Rico
January 26	Site visit to Biotechnology Teaching Laboratory, State University of New York, Stony Brook
February 4–6	Department of Energy Workshop, *Human Genetics and Genome Analysis,* DNALC and Banbury Center
February 8–11	Department of Energy Contractors Workshop, Santa Fe, New Mexico
February 13–14	Department of Education Follow-up Workshop, *Advanced DNA Science,* University of Chicago, Chicago, Illinois
February 15–17	Coalition for Education in the Life Sciences Meeting, Marine Biological Laboratory, Woods Hole, Massachusetts
February 19	Biology Teachers Inservice Training Committee Meeting, National Research Council, Washington D.C.
February 23	Site visit by Dennert O. Ware, Boehringer Mannheim Corporation
February 27–28	National Science Foundation Follow-up Workshop, *Advanced DNA Science,* DNALC
March 4	Corporate Advisory Board Meeting and Reception, DNALC
March 8–10	Site visit by Ian Muchamore, Wellcome Centre for Medical Science, London, England
March 13–14	Howard Hughes Medical Institute Follow-up Workshop, *DNA Science,* Edison Career Center, Montgomery County, Maryland
March 30	Site visit by Dennis Bittisnich, Australian National University, Canberra, Australia
March 31–April 1	Scholar in Residence Program, SUNY, Purchase, New York
April 5	Site visit by Tom Zinnen and Michael Patrick, University of Wisconsin, Madison, Wisconsin
April 27	*Great Moments in DNA Science* Honors Student Seminar, DNALC
May 4	*Great Moments in DNA Science* Honors Student Seminar, DNALC
May 7	Corporate Advisory Board Meeting, DNALC
May 10–12	Collaboration with Ray Gladden, Carolina Biological Supply Company, Burlington, North Carolina
May 11	*Great Moments in DNA Science* Honors Student Seminar, DNALC
May 13–15	Collaboration with Helen Donis-Keller, Washington University, St. Louis, Missouri
May 18	*Great Moments in DNA Science* Honors Student Seminar, DNALC
May 20	Corporate Advisory Board Meeting and Reception, DNALC
May 24–June 4	Department of Education, *Advanced DNA Science* Workshop, Columbia University, New York, New York
June 1	Corporate Advisory Board Meeting and Reception, DNALC
June 7–11	National Science Foundation Workshop, *DNA Science*, John McDonogh High School, New Orleans, Louisiana
June 14–25	Department of Education Workshop, *Advanced DNA Science*, University of California, Northridge, California
June 28–July 2	National Science Foundation, *DNA Science* Workshop, University of Utah, Salt Lake City, Utah
June 28–July 2	*Fun With DNA* Workshop, Portledge School, Locust Valley, New York
June 28–July 2	*DNA Science* Workshop, DNALC
June 29–July 1	National Science Foundation Workshop, *Exploring Human Genetics,* Titusville Middle School, Poughkeepsie, New York

July 6–30	National Science Foundation *Leadership Institute in Human and Molecular Genetics,* DNALC
July 12–16	Barker Welfare Foundation Minority Workshop, *Fun With DNA,* A. Phillip Randolph High School, New York
July 19–23	*Fun With DNA* Workshop, Portledge School, Locust Valley, New York; Barker Welfare Foundation Minority Workshop, *Fun With DNA,* A. Phillip Randolph High School, New York
July 26–30	*Fun With DNA* Workshop, Portledge School, Locust Valley, New York
July 26–August 6	National Science Foundation Workshop, *Advanced DNA Science,* University of Puerto Rico, Rio Piedras, Puerto Rico
August 2–6	*Fun With DNA* Workshop, Portledge School, Locust Valley, New York
August 9–13	National Science Foundation Workshop, *DNA Science,* University of Puerto Rico, Rio Piedras, Puerto Rico; *Fun With DNA,* Portledge School, Locust Valley, New York; Barker Welfare Foundation Minority Workshop, *Fun With DNA,* DNALC
August 16–20	*Advanced Placement Workshop,* Stanford University, Palo Alto, California; Barker Welfare Foundation Minority Workshop, *Fun With DNA,* DNALC
August 16–27	National Science Foundation Workshop, *Advanced DNA Science,* University of Washington, Seattle, Washington
August 24–26	National Science Foundation Workshop, *Exploring Human Genetics,* DeWitt Middle School, Ithaca, New York
August 23–27	High School Student/Faculty Workshop, DNALC
August 30–September 2	*Microbes, Meteorites, and the Mind* Workshop, DNALC
September 8	Premiere, *Long Island Discovery,* DNALC
September 15	Site visit by Kyle Vermillion, Westminster School, Atlanta, Georgia
September 30	Corporate Advisory Board Meeting/Museum preview and Open House, DNALC
October 8–9	National Science Foundation Follow-up Workshop, *DNA Science,* John McDonogh High School, New Orleans, Louisiana
October 15	Site visit by Greg Baird and Laura Leber, Genentech, South San Francisco, California
October 24–27	International Conference on Public Understanding of Science and Technology, Chicago Academy of Sciences, Chicago, Illinois
October 29	Baring Brothers Workshop, Cold Spring Harbor, New York
November 11	Eugenics lecture, Banbury Center, Cold Spring Harbor, New York
November 18–21	National Association of Biology Teachers National Meeting, Boston, Massachusetts
November 29–December 3	Human Genome Diversity Training Workshop, Porto Conte Research and Training Laboratories, Sardinia, Italy
December 15–17	National Science Teachers Association Annual Meeting, Orlando, Florida