DNA Learning Center

Annual Report

1992

Cold Spring Harbor Laboratory

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DNA LEARNING CENTER

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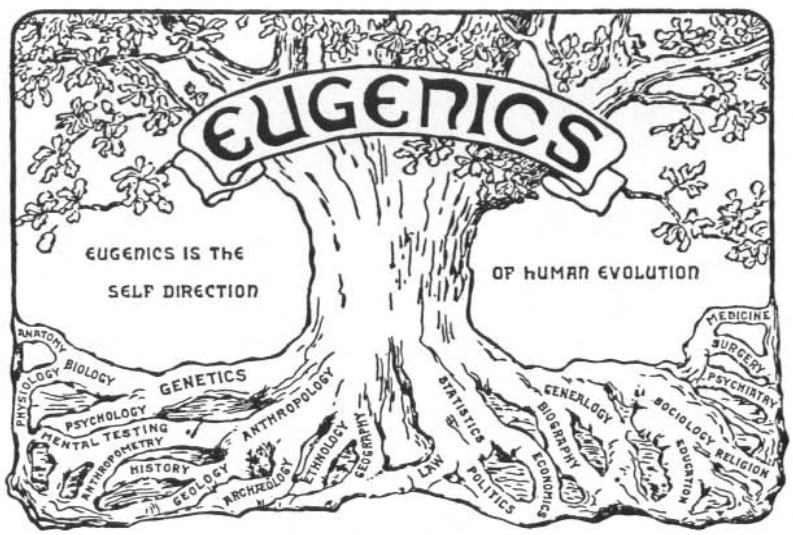
During his tenure as founding director of the National Center for Human Genome Research, Laboratory Director James Watson called for at least 3% of genome research funds to be devoted to examining the ethical, legal, and social implications of genetics research. This was a bold and unprecedented step to tie biological research directly to its social effects. Dr. Watson's sensitivity to the social issues of genetics was heightened by his knowledge of its history. Indeed, the New York metropolitan area provides an especially good vantage point from which to examine the striking parallel between the rapid advance of molecular genetics and its applications to human disease in the last several decades of the 20th century, and the explosive birth of modern genetics and its applications to eugenics during the first several decades of the century.

The era of modern genetics began in 1900 with the rediscovery of Mendel's laws, which had laid dormant in an obscure European journal since 1865. Researchers who were then trying to recreate evolutionary processes under controlled conditions—the so-called experimental evolutionists—were quick to adopt Mendelian genetics as a tool for analyzing inheritance in their laboratory plants and animals. From such a background came Thomas Hunt Morgan, whose group at Columbia University was largely responsible for elaborating the mechanisms of Mendelian inheritance, and Charles Davenport, director of the Station for Experimental Evolution at Cold Spring Harbor (the forerunner of the current Laboratory) from 1904 to 1924. Davenport and other early practitioners of genetics also had backgrounds in plant and animal breeding. Thus, the Station for Experimental Evolution resembled an experimental farm, complete with cornfields, hen houses, and grazing sheep.

The Station for Experimental Evolution.

It was not long before researchers began attempts to apply Mendelian genetics to human inheritance. Davenport helped usher in the study of human genetics with a 1907 publication in the journal *Science* explaining the inheritance of blue and brown eye color, and he later published papers on epilepsy, Huntington's chorea, albinism, and neurofibromatosis. Mendelian analysis of human characteristics merged easily with the growing eugenics movement, founded in Europe in the late 1800s, which Davenport aptly described as "the science of human improvement through better breeding." In 1910, Davenport obtained sponsorship from the widow of E.H. Harriman (the railroad robber baron) to establish a Eugenics Record Office at Cold Spring Harbor. Until its disbandment in 1940, the Eugenics Record Office was the epicenter of the American eugenics movement, training eugenics field workers to collect pedigree data and amassing 750,000 genetic records. The institution also provided advice "concerning the eugenical fitness of proposed marriages"; eugenic family histories were fashionable among families who could afford the cost. By 1920, Eugenics exhibitions and "Fitter Families Contests," appraising the genetic quality of human families, were found alongside livestock and produce competitions at state fairs.

The eugenicists were not content merely to chart human inheritance or haggle over whose families were fittest, they began to develop very definite ideas about what constituted the right genetic stuff. Equipped with "scientific" studies purporting to show the Mendelian inheritance of socially unacceptable traits such as nomadism, feeblemindedness, violent temper, lack of moral control, and shiftlessness, they began to force through restrictive and coercive eugenics legislation. Eugenicists' "data" on the genetic inferiority of Jews, blacks, Asians, and southern and eastern European immigrants provided the "scientific" basis for the Johnson Immigration Restriction Act of 1924, which effectively closed the floodgate on the waves of early 20th century immigrants who arrived primarily at Ellis Island, New York, and from whom a majority of Americans living today are descended. By 1931, 30 American states had laws allowing the involuntary sterilization of sex offenders and habitual criminals, as well as the insane and mentally retarded. Historians now believe these mandates were also used as an excuse to sterilize individuals on the basis of race and socioeconomic status. Germany passed its first law for the compulsory sterilization of "hereditary defectives" in



A portion of a certificate awarded to meritorious exhibits at the Second International Congress of Eugenics in 1921 at the American Museum of Natural History.

1933; children of mixed race were sterilized beginning in 1937; euthanasia of children with birth defects commenced in 1938; and "special actions" to exterminate Jews, Gypsies, and other "undesirable elements" began in 1941.

It is easy to dismiss the eugenics movement as pure quackery that could never again be foisted upon society. However, eugenics was branded only in retrospect. In its time, the eugenics movement was respectfully regarded as bona fide science and drew into its circle a number of eminent scientists, philanthropists, and institutions. The recent "ethnic cleansings" in Cambodia and the former Yugoslav Republics illustrate the ever-present potential for abuse of personal freedom in a social climate that values racial purity.

The Social Consequences of Genetic Screening

Perhaps the most immediate social challenge presented by the Human Genome Project will come from the rapid growth of mass genetic screening to detect asymptomatic individuals at risk of developing a disease or of passing a disease gene on to offspring. DNA-based tests are now available for approximately 40 genetic diseases, but the current expense of such tests limits screening primarily to individual families with known risk factors. As technology becomes less expensive, population genetic screening should become as commonplace as cholesterol screening is today. Nobel laureate Walter Gilbert, who discovered a key method for sequencing genes, predicts that *routine* screening will be available for as many as 50 genetic conditions by the year 2000 and for several thousand diseases by 2010.

Retrospective studies of the first mass-screening programs of the 1970s—notably for Tay-Sachs disease and sickle cell anemia, as well as contemporary programs for screening neural tube defects and X-linked disorders—confirm several dangers to be faced as genetic screening becomes widely available:

- Acceptance of genetic screening correlates with increased income and formal education.
- Understanding and retention of genetics information presented by medical professionals correlates with increased income and formal education.
- Families with greater increased income and formal education are less willing to accept the risk of bearing a disabled child.
- Misunderstanding and misinformation about carrier status can stigmatize asymptomatic carriers as being at increased risk for medical problems and subject them to employment and insurance discrimination, as well as psychological distress.
- Many women who receive a positive screening result indicating the possibility of a serious genetic defect in their unborn fetus show little understanding of the testing process, the seriousness of the situation, or their options. These women regard the discovery of an unexpected genetic defect as a medical emergency, whose resolution should be decided by their doctor, rather than as a potential ethical dilemma for themselves.

These results are consistent with National Science Foundation studies conducted over the last three decades, showing that scientific literacy and attention to scientific information correlate with increased income and formal education. In

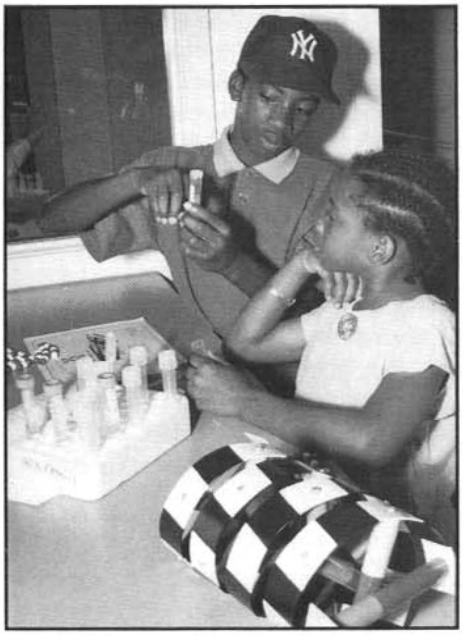
conglomerate, the data suggest that a clinic or doctor's office is not the proper context for a first exposure to genetic testing and that public education campaigns and counseling primarily affect those individuals with some pre-exposure to genetics concepts. Poorer and less educated individuals are more likely to forego genetic testing or cede decisions about genetic testing to their doctors. This suggests a frightening scenario in which poorer and less educated families face an increasing burden of genetic disease, driving them further into disadvantage.

Funding from the Ethical, Legal, and Social Issues Program of the Human Genome Project is currently focused on informed patient consent to genetic testing and protection of private genetic records. Many argue that these issues have, in fact, already been thoroughly examined in similar contexts of general medicine. However, relatively little funding has been devoted to the problem of building a genetically literate public that understands elements of personal genetic health and participates effectively in policy issues of genetic information. Even the most informed of our great private foundations involved in education and social policy still regard genetics as an essentially scientific problem. They have yet to internalize the looming social impacts—both hopeful and distressing—of genetic medicine at the close of the 20th century.

Extending our Expertise to Minority and Disadvantaged Settings

If we accept the premise that minority populations stand the greatest risk of being excluded from the benefits and harmed by the misuse of genetic technology, then genetic literacy issues are especially relevant to the metropolitan New York area, an historical melting pot of minority, racial, and ethnic groups. Minorities compose 64% of 1.3 million precollege students enrolled in public schools in New York City, Nassau County, and Suffolk County. Many of these children are ill-prepared by home experiences when they enter elementary school and are at elevated risk of educational failure. Stigmatized as slow learners, at-risk students are often given remedial exercises that do little to develop problem-solving skills or to place learning in the context of their own interests and experiences. Thus, they fall further and further behind throughout elementary and secondary school. This vicious cycle appears to affect science interest and aptitude disproportionately; the percentage of minorities receiving undergraduate and graduate degrees in scientific disciplines is far below their representation in the general population.

We believe that genetics is an especially appropriate vehicle to reconnect minority/disadvantaged students with science. As a paradigm of "whole learning," genetics offers an almost unparalleled opportunity to integrate concepts across disciplines and to relate technology to an individual's life and culture. Genetics issues entail discussions of personal autonomy, allocation of public resources, and equity for women, minorities, and the disabled. Emphasizing sensitivity to minority and disabled issues of genetics is consistent with the objectives of the Americans with Disabilities Act and New York City's so-called "rainbow curriculum." The DNA Learning Center's (DNALC) minority/disadvantaged outreach is an interdisciplinary micro-application of the principles embodied in the Accelerated Schools Project of Stanford University and the Center for Educational Innovation of the Manhattan Institute. These and other projects have "rescued" urban schools from the downward spiral into academic failure by emphasizing academic acceleration, teacher innovation, and community involvement.



A participant in a *Fun With DNA* summer camp for minority and disadvantaged students explains his DNA extraction experiment to his younger sister.

The recruitment of minority educator Robert Willis, in July, allowed us to initiate a measured, substantive response to the problems of minority/disadvantaged genetics education. With support from the William Randolph Hearst Foundation and the Barker Welfare Foundation, three *Fun With DNA* summer camps were held in August serving 54 minority and disadvantaged students from ten Long Island schools. Contributions from Long Island businesses allowed us to provide scholarships for 155 students to attend laboratory field trips to the *Bio2000* Laboratory during the academic year.

Advance planning was completed on an *Intensive Enrichment* Program, which will become our major vehicle to provide in-school and supplemental resources to support the science literacy needs and career aspirations of minority and disadvantaged students in the New York metropolitan area. The object is to use genetics as a focal point for accelerated science instruction extending from upper elementary through high school. Five *Resource Clusters* of elementary and middle schools will be built around hub high schools in Harlem, Brooklyn, Queens, the Bronx, and mid-Long Island. Each of the five hub high schools will maintain basic equipment sets needed for genetics laboratories to be shared with elementary and middle schools in their *Resource Cluster*. Specialized equipment will be available on loan from the DNALC for advanced experiments and student research projects. Faculty will receive training during the summer through the DNALC's established workshops. Modeling of teaching strategies by DNALC staff and easy availability of technical support will lead *Intensive Enrichment* teachers into independent instruction.

Wealthy school districts of Long Island have been the proving ground and initial beneficiaries of the DNALC's curricula and teacher training. Thus, we also envision a "Robin Hood" aspect to the *Intensive Enrichment* program through which these wealthy school systems can work together with resource-poor school systems to promote excellence in science education. A number of Long Island school districts with well-established genetics instruction have agreed to be part-

nered with *Intensive Enrichment* schools for classroom observation, teacher mentoring, and cooperative student projects. Previously trained faculty in the partner districts will be linked in a resource group with *Intensive Enrichment* faculty to stimulate innovation, curriculum coordination, and resource sharing across grade levels.

We also want to help establish the *Intensive Enrichment* schools as "community science centers" to provide continuing genetics education to parents and community members. By stimulating collaboration between teachers, parents, community service groups, genetics researchers, genetic counselors, and genetic disease foundations/support groups, we hope to develop community infrastructures to support diffusion of public health messages. We intend to rotate to each *Resource Cluster* our mobile mini-exhibit on genetics—the *Genetic Video Arcade*. The arrival of the exhibit will create a significant "event" around which to organize a rich program of in-school field trips and seminars, student laboratories, and a community genetics fair. Analogous to a student science fair, the community genetics fair would include a number of public events, including seminars, panel discussions, dramatic presentations, debates, mock trials, student laboratory demonstrations, and research projects.

An Educational Imperative

Modern constructivist and cognitive models of learning assert that individuals build knowledge by integrating new information into a pre-existing network of associations. According to these models, decisions about personal and social impacts of genetics must be tied to pre-existing knowledge and value systems developed during childhood and adolescence. This line of reasoning leads to the inescapable conclusion that the precollege school system must be responsible for ensuring that all school children receive sufficient pre-exposure to genetics to empower their future decision-making. This conclusion has been echoed at least twice in the last two decades in the strong recommendations of a 1975 National Academy of Sciences panel and a 1983 Presidential Commission:

> It is essential to begin the study of human biology, including genetics and probability, in primary school, continuing with a more health-related program in secondary school.... Sufficient knowledge of genetics, probability, and medicine leading to appropriate perceptions of susceptibility to and seriousness of genetic disease and of carrier status cannot be acquired as a consequence of incidental, accidental, or haphazard learning.
>
> Efforts to develop genetics curricula [at all levels] and to work with educators to incorporate appropriate materials into the classroom...should be furthered. The knowledge imparted is not only important in itself but also promotes values of personal autonomy and informed public participation.

There is growing awareness among educators that a basic understanding of genetics, disease risk, and health choices is an essential element of cultural literacy—as important in the education of a developing child as is a basic understanding of hygiene and nutrition. Systematic genetics education should begin in elementary school with principles of human variability, inheritance, and disease risk; progress in middle school to more formal aspects of Mendelian analysis, modern gene manipulation, and genetic testing; and culminate in high school

with elements of gene regulation and signal transduction. This effort would fulfill three important objectives, which essentially parallel student development:

- To inculcate basic tenets of genetic literacy that are essential for all students as they assume management of personal and family health care as adults.
- To help prepare college-bound students for their future roles as opinion leaders in government, industry, education, medicine, and law.
- To maintain and broaden the interest of the approximately 15% of science-interested students who are intent on biology or health-related majors, and to stimulate this interest in other motivated students.

Teacher Training and Evidence of Success

The social imperative of the Human Genome Project demands the development of teaching resources capable of bringing science education into the gene age. However, the majority of precollege teachers in the United States have been out of college for 10–20 years, precisely the period of explosion in genetic biology. The majority of all 10th to 12th grade science teachers have completed a Master's degree, generally needed for salary advancement and tenure, so fewer are returning to college for continuing education. At the same time, evidence suggests that most teachers rely heavily on textbooks, which tend to emphasize the formal aspects of Mendelian inheritance using plant and animal examples.

With these problems in mind—and in advance of the Human Genome Project—the first major precollege training programs in molecular genetics were initiated in 1985, notably here and at Georgetown University. Our analysis of a genetics education database developed by the National Academy of Sciences indicates that there are now approximately 30 major, ongoing training programs for precollege teachers in genetics/biotechnology that are administered through academic institutions in the United States. The majority of these programs focus on molecular genetic techniques, are targeted at the high school level, and are clustered in the urban east, California, and several midwestern states. Most training programs include the "core" techniques of transformation (putting DNA into bacteria), restriction (cutting DNA with enzymes), and ligation (recombining DNA). Student laboratories on these core techniques were not taught prior to 1985, and gearing up for them entails significant teacher investment in supplies, equipment, and time.

The rapid adoption of these relatively sophisticated laboratories in molecular genetics at the advanced high school level provides a clear example of the dramatic effects of teacher training, especially when coupled with a national mandate for innovative instruction. Follow-up surveys of 443 faculty trained by DNALC staff in 1987–1988 showed that significant numbers had implemented laboratories on transformation (35%), restriction (25%), and ligation (18%) during the school year following their workshop experience. The notion that hands-on experience in molecular genetics is essential for college-bound students was legitimized in 1989, when the Educational Testing Service recommended two of the core DNA manipulation laboratories for students who take the nationally administered Advanced Placement Biology curriculum. Following this "mandate," implementation of the core laboratories rose substantially for 242 teachers trained in 1989–1990: 51% for transformation, 42% for restriction, and 27% for

A *Fun With DNA* participant examines fruit fly mutations with a family member on the final Parent Participation Day of the workshop.

ligation. Extrapolating these rates to the estimated 3,500 American teachers trained thus far suggests that there are approximately 100,000 precollege student exposures to core DNA manipulation laboratories annually, and $2 million are spent on needed equipment, supplies, and reagents.

Analysis of our database also suggests that several hundred American high schools now include substantial laboratory-based units or elective courses in molecular genetics. Laboratory genetics units are typically incorporated into existing electives, such as anatomy, physiology, biology II, honors biology, and research. In collaboration with Fred Gillam, we completed a survey of 190 college students who had taken the molecular genetics course he has offered at Sachem High School since 1987. The data strongly suggest that genetics electives, like that offered at Sachem, influence science-interested students to choose college majors in biology and health-related disciplines and to consider careers in these fields. The data also suggest that genetics courses preferentially support young women's aspirations for careers in the biological sciences.

Moving Genetics Education into the Elementary Schools

Despite evidence of success of introducing modern genetics at the advanced high school level, we and others have come to regard the elementary schools as the first front in the battle for genetic literacy. Here, student and teacher enthusiasm, flexible scheduling, and lack of standardized curricula greatly simplify instructional change. Elementary teachers, who work with the same class of children all day, have an unparalleled opportunity to use genetics as the hub of a rich learning network that links skills and concepts across the disciplines of reading, writing, math, and science. This is consistent with a recommendation of the National Research Council's 1990 study of American biology education that "science stories" be integrated into elementary language arts. Early genetics education should focus on human development, variability, and health. Sensitive dialogue on social and ethical issues may be especially important to elementary children, who are in the process of forming fundamental attitudes. Genetics also offers ideal subject matter to explore elements of probability included in the national math standards for students, including collecting and analyzing data, drawing samples, and comparing predicted versus experimental ratios.

The DNALC's initial forays into elementary genetics education date to 1989 when we piloted the *Fun With DNA* summer camp. With funding from the William Randolph Hearst Foundation, in 1991 we expanded the summer program to six camps and initiated an academic-year program of laboratory field trips for elementary and middle school students. This year, we began a major new initiative, *Genetics as a Model for Whole Learning in Elementary Science*. Six local school districts—Commack, Great Neck, Half Hollow Hills, Locust Valley, Plainedge, and Roslyn—each pledged $10,000 over two years to support the systematic introduction of genetics modules in their elementary and middle school classes. The object is to train classroom teachers, usually with backgrounds in reading and language arts, to use genetics as a means to link science with the more familiar disciplines of math, geography, and the humanities. Under the program, each district receives 100 hours of consultation with DNALC Education Manager Jane Conigliaro. The program's first year involved 27 faculty and 1,000 students at 15 elementary and middle schools.

In the small school districts of Long Island, we are thus beginning to see working models of science education for the gene age, incorporating hands-on learning about genetics at several stages during child and adolescent development. Typically composed of only two or three elementary schools, one middle school, and one high school, these districts present ideal situations in which to introduce coordinated and system-wide instructional innovation. This is exactly what we envisioned in 1985, when we began our educational efforts on Long Island.

Another Busy Year of Laboratories, Lectures, and Workshops

The *Bio2000* Laboratory was kept very busy during the academic year, with 3300 precollege students participating in laboratory field trips. During a typical week, we now offer five high school laboratories in the mornings and three middle school laboratories in the afternoons. Teachers choose from a "menu" of laboratories, designed to complement science courses typically offered at local schools:

	Grade Level	Time
Variability and Inheritance	5–8	1.5 hours
Corn Genetics and Mendelian Inheritance	5–8	1.5 hours
Cells, Chromosomes, and Mutations	5–8	1.5 hours
DNA Structure and Recombination	5–8	1.5 hours
Bacterial Transformation	9–12	2 hours
DNA Restriction Analysis	9–12	3 hours
Human DNA Fingerprinting	11–12	2 hours

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 1,000 students and teachers. Included in the audience were many "regulars"—faculty who have attended each year since the inception of the lecture series in 1985. This year's lectures aptly illustrated molecular approaches to basic biological problems, as well as applications in health and law:

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

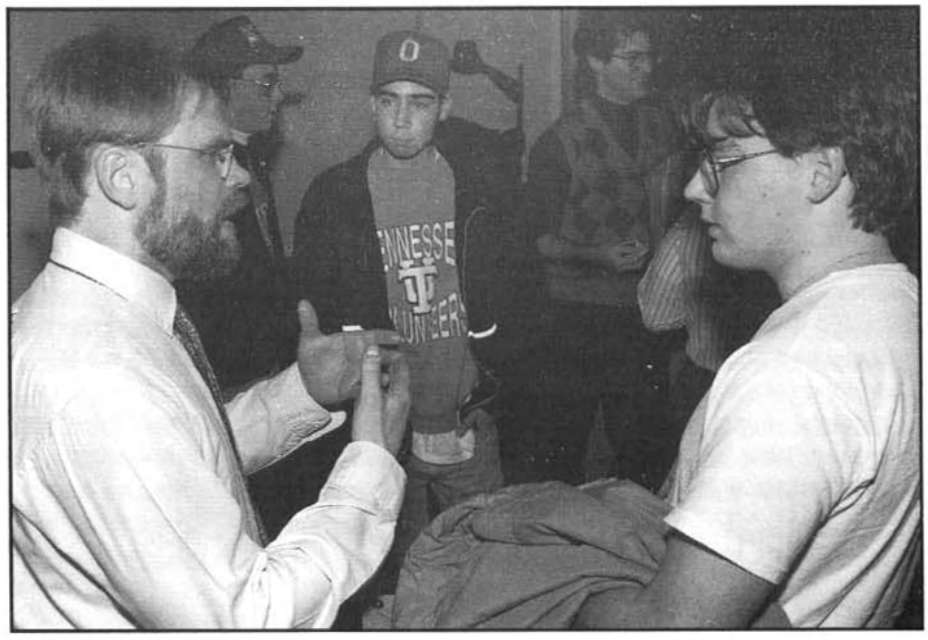
"Using DNA in Criminal Investigations," Robert Shaler, New York City Medical Examiner's Office.

"The Molecular Basis of Learning and Memory," Ronald Davis, Cold Spring Harbor Laboratory.

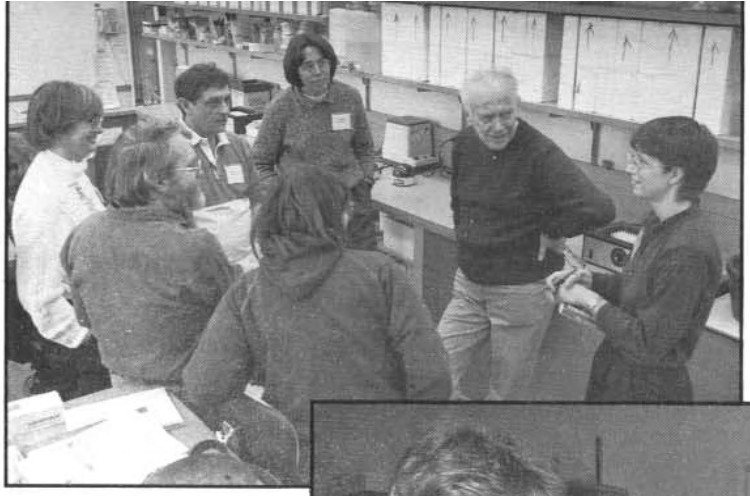
"Human Immunodeficiency Virus Variability," Winship Herr, Cold Spring Harbor Laboratory.

Summer has traditionally been our busiest time, and the summer of 1992 was no exception. With support from the National Science Foundation, the Department of Education, and the Howard Hughes Medical Institute, a total of 18 training workshops were conducted for elementary through college faculty. Margaret Henderson assisted lead middle school teachers trained in previous summers to conduct "second-round" workshops for 80 additional faculty in New York and Maryland. The popular *DNA Science* Workshop—taught by David Micklos and now in its eighth year of operation—reached 155 high school teachers at workshops held in Arkansas, Kentucky, Maryland, Nevada, and Puerto Rico. Mark Bloom presented his *Advanced DNA Science* Workshop to 100 college faculty at workshops in New York, Washington, D.C., Illinois, and Puerto Rico. Student workshops are becoming an increasingly large component of our summer activities. The DNALC was site for six *Fun With DNA* summer camps attended by 128 5th and 6th graders, including three workshops especially designated for minority and disadvantaged students. Research-oriented high school students (19) from local school districts outnumbered teachers at the *DNA Science* Workshop held at the DNALC.

With funding from the Department of Energy's program on the Ethical, Legal, and Social Issues of Human Genome Research, we continued to hold workshops for opinion leaders and public policy makers. Each of two workshops held in 1992 drew together an eclectic group of administrators and communicators from federal and state governments, genetic support groups, foundations, associations, the mass media, the legal community, and the ethics community—all of whom desire to deepen their insight into human genetics. Most participants come to the workshop with rather extensive "book knowledge" on genetics, but with only fragmentary understanding of the technology upon which modern genetic



Kenneth Culver addresses student questions after his *Great Moments* lecture on gene therapy.



James Watson (second from right) speaks with *Advanced DNA Science* follow-up workshop participants after his talk on the Human Genome Project.

analysis is based. Thus, the workshop aims to deepen insight into the research process and to fill in gaps in participants' understanding. Jointly administered with our friend Jan Witkowski, the 3-day workshop combines high-level seminars at his Banbury Center with hands-on laboratories at the DNALC that illustrate elements of chromosome mapping, gene library construction, and human DNA polymorphisms. Seminars provided experts' views of the progress and problems of genetics research:

"The Human Genome Project," James Watson, Cold Spring Harbor Laboratory.

"Population Screening for Genetic Diseases," Nancy Press, UCLA Medical Center.

"Counseling for Human Genetics Diseases," Patricia Ward, Baylor College of Medicine.

"Ethical Implications of Human Molecular Genetics," Thomas Murray, Case Western Reserve University School of Medicine.

"Analyzing the Molecular Genetics of Cancer," Eric Fearon, Johns Hopkins University School of Medicine.

"Searching for the Genetic Basis of Learning and Memory," Ronald Davis, Cold Spring Harbor Laboratory.

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

Cindy Cutshall (second from left) performs a laboratory with her parents Susan (at left) and William Cutshall during the DOE opinion leaders workshop. Cindy is one of the first individuals undergoing gene therapy for ADA deficiency.

Initiating a Major Capital Development Program

The Laboratory's Board of Trustees has endorsed a $3.5 million capital development program to create the physical resources for the DNALC to take on an expanded role as a prototype "Human Genome Education Center." The three-phase program is expected to be completed in 1994:

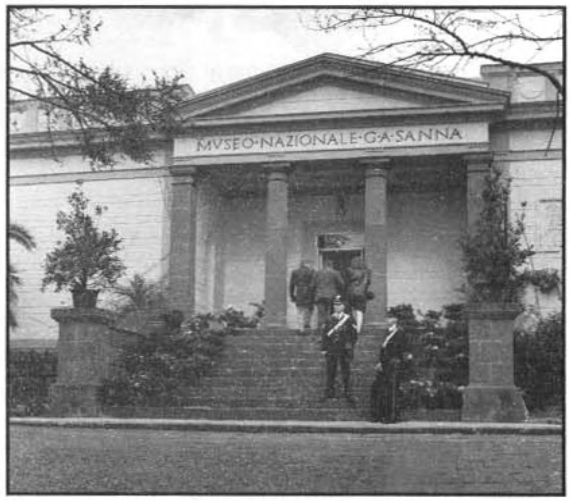
- Phase I: Purchase of the DNALC property from Cold Spring Harbor Central School District at the conclusion of its lease/option on December 31, 1992.
- Phase II (January–June, 1993): Redevelopment of the existing property, including renovation of a 104-seat auditorium, renovation of galleries, installation of new exhibits, installation of a computer multimedia laboratory, installation of fire sprinklers, and improvement of visitor parking and handicap access.
- Phase III (Fall 1993–Fall 1994): Construction of a 3,500-square-foot *BioMedia* addition to the south side of the building, including a second teaching laboratory, library, and an atrium/lunchroom. The term *BioMedia* engenders our goal to explore ways to link experimental, computer, and audiovisual resources to encourage understanding of biological concepts. The new and redeveloped facilities will allow students to move between biochemical experiments, microscope observations, and parallel computer experiences that illustrate molecular events.

The capital program is based on an architectural design by Centerbrook Associates, who have been responsible for architectural design at the Laboratory for more than a decade. In November, the Suffolk County Industrial Development Agency approved a tax-exempt municipal bond for the purchase and redevelopment of the facility. Approval to proceed with the capital program was based upon receipt of lead grants in 1991 from the Stone Foundation ($250,000) and the Weezie Foundation ($100,000), and in 1992 from Cablevision Systems Corporation ($250,000) and the E.S. Webster Foundation ($50,000). We were also very pleased to receive from Beckman Instruments gifts of an L8-70M ultracentrifuge and GS-6 tabletop centrifuge.

International Collaborations

We were happy for an opportunity to aid long-time friend Marcello Siniscalco in his efforts to bring into operation a new genetics institute on the Sardinian coast: the Porto Conte Research and Training Laboratories. In the context of recent revelations in Italy of millions of dollars misspent for bogus public works projects, the Porto Conte Laboratory is one of only a very few successful projects to bring technological development to the poorer regions of Italy. Sardinia is an almost ideal site for a laboratory on human genetics. The Sardinian people represent essentially a closed gene pool, derived from a distinctive prehistoric culture and cut off from major immigration for centuries.

Marcello also has received seed money from the Italian Ministry of University, Scientific, and Technological Research, to develop a plan for an education center adjacent to the research laboratories. To help publicize this educational mission, we were subcontracted to develop a prototype *Genetic Video Arcade* for display in Sardinia. Susan Lauter collaborated with Paola Melis to translate four



Marcello Siniscalco of Sardinia, Italy views one of the computer presentations of the *Genetic Video Arcade* displayed at the Museo Nazionale in Sassari (right).

interactive computer presentations into Italian and to mail 1,000 pounds of computers and display modules to Sardinia. Four computer modules and a wide-screen video projector were installed in the Museo Nazionale Sanna in Sassari. The *Genetic Video Arcade's* frank modernism—in design and content—contrasted with a contemporaneous exhibit of Columbian documents and the museum's noteworthy collections of bronze-age artifacts. The arcade was visited by 7,000 students during the Italian national "Week of Scientific Culture," April 8–16, which included lectures by Italian Nobel laureate Luigi Cavalli-Sforza and Sir Walter Bodmer, director of the Imperial Cancer Research Fund. Response in Sassari was so favorable that the *Genetic Video Arcade* was set up in Genoa as part of the Columbian 500th anniversary celebrations in June.

We initiated a new collaboration with the municipality of Svalov, a small agrarian community in Skania Province of southern Sweden. Only a brief ferry ride away from Copenhagen, Skania has a long history in agricultural genetics. The horse-breeding station at Flyinge has functioned continuously since the 12th century and has been responsible for developing the Swedish "warm-blood," which is in great demand for high-level equestrian sports. The company Svalof AB was established in 1886 to develop grain, forage, vegetable, and oil seeds for use by farmers throughout Sweden. Thus, it is not surprising that the municipality of Svalov is now developing plans for a science education center to focus on agricultural genetics.

After visiting the DNALC in January, the Svalov planners decided that the DNALC was a useful model for the science center they envision in Southern Sweden. Four elementary and high school teachers from Svalov were trained to perform hands-on genetics laboratories during summer workshops at the DNALC. To help publicize the proposed science center, David Micklos was invited to participate in "Gene Vision," an exhibit on agricultural genetics and accompanying interpretive activities during several weeks in October. The exhibit included Swedish translations of two computer presentations from our *Genetic Video Arcade*; seminar speakers included Swedish scientist Ulf Pettersson, who did postdoctoral research at Cold Spring Harbor Laboratory in 1971–1972. The exhibit received 1500 visitors, and 1200 persons (aged 9–65) participated in hands-on laboratories on DNA restriction, bacterial transformation, DNA structure, and Mendelian genetics.

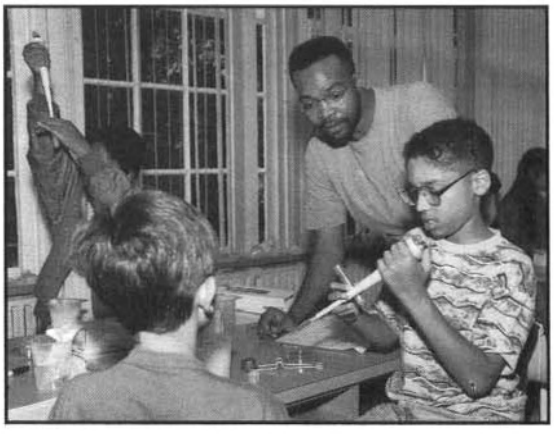
Staff and Activities

In early summer, Margaret Henderson left the DNALC to accept a position as Head of Library Services at the main Laboratory campus. As Education Manager, Margaret fit in easily with the rest of our small staff and proved herself as a gifted instructor and untiring organizer. We were happy that Margaret was able to find within the Laboratory a position that so well utilizes her graduate training in library science, but we miss her team spirit and even disposition.

The loss of Margaret from our staff was eased by our success in recruiting Robert Willis, who joined the DNALC staff in July. As Special Programs Manager, Robert is responsible for developing and administering programs targeted for minority and economically disadvantaged students in the New York metropolitan area. A native of Tallahassee, Florida, Robert received his undergraduate degree in biology from Florida State University. Prior to joining the DNALC, he taught biology, general science, chemistry, and math at Ballou Senior High School in Washington, D.C. He has also taught English as a Second Language to non-English speaking adults and served as an extension math and science teacher. In recent years, Robert received teacher fellowships from the American Society for Biochemistry and Molecular Biology, the Cafritz Foundation, and the Foundation for Advanced Education in the Sciences. As part of his fellowship research, he conducted a study of biotechnology curricula and developed plans to integrate biotechnology into the curriculum of the Washington, DC public schools; he intends to continue this work while at Cold Spring Harbor.

We were also thankful for the opportunity to work with Twana Adams, another gifted and energetic minority educator. An instructor at the Bronx Comprehensive Night High School, Twana assisted with the minority *Fun With DNA* camps and organized a very successful training workshop that drew minority educators from throughout the New York metropolitan area. We anticipate that Twana will play a key role in organizing our new *Intensive Enrichment* program, acting as our agent in her hometown Harlem, as well as in the Bronx.

The laboratory-intensive nature of the *Fun With DNA* summer camps requires increased supervision for 5th and 6th grade participants. Assisting Jane Conigliaro with laboratory instruction at the 1992 camps were Diane Jedlicka, of the Roslyn OMNI Gifted Program, and Adele Nicefero, of the Hicksville Academic Enrichment Program. We owe a special debt of gratitude to these lead educators, and their students, for bringing genetics education into the elementary classroom. They were among the very first to use the DNALC as a resource for



Twana Adams (above, at right) and Robert Willis (below, second from right) oversee *Fun With DNA* students.

DNA Learning Center Staff. (*Top*) Robert Willis, Mark Bloom, Sandy Ordway, Mark Staudinger, David Hollman. (*Bottom*) Jane Conigliaro, David Micklos, Susan Lauter, Ken Bassett.

gifted/talented instruction and provided the impetus for the initial development of the *Fun With DNA* camp. Student aides Tara Marathe, of Northport High School, and Lina Hwang, of SUNY, Stony Brook, provided campers an additional measure of personal attention.

Student interns from neighboring school districts worked behind the scenes to prepare reagents used in student field trips during the academic year and for teacher training workshops during the summer. After ably assisting Mark Bloom with an intense 8-week schedule of college faculty workshops in the summer, Amy Phillips joined the sophomore class at SUNY, Geneseo, to continue her major in biochemistry. Following Amy's departure, Mark Staudinger, of Cold Spring Harbor High School, filled her position as senior intern. Mark assisted with 4 weeks of summer faculty workshops and assumed responsibility for overseeing several new sophomore interns: Ken Bassett, of Massapequa High School; Andrea Conigliaro, of St. Anthony's High School; and Michael Conigliaro, of Cold Spring Harbor High School. Cold Spring Harbor senior David Hollman continued to focus primarily on computer applications, assisting Sue Lauter with the development of multimedia educational programs. We were also fortunate to take on Paul Kwitkin, a senior at Commack High School with background in DNA research at SUNY, Buffalo. Claudio Siniscalco, of Westminster School in London, returned for his second summer, assisting at several faculty workshops and developing multimedia programs.

David Micklos participated in important studies being carried out by two branches of the National Academy of Sciences. He is an appointed member of a National Research Council committee that is assembling a report on effective methods of in-service training for precollege biology teachers. He prepared a background paper that was used as a basis for educational recommendations proposed by an Institute of Medicine committee on genetic testing. Mark Bloom began consulting for Ralph Appelbaum Associates, Inc. on the design of biotechnology exhibits for the new National Science and Technology Museum in Taiwan, due to open in 1993.

Publications

Bloom, M., G. Freyer, and D. Micklos. *Laboratory DNA science: An introduction to recombinant DNA technology and methods of genome analysis.* (In press.)

Micklos, D. Genetic Testing: An educational imperative to our schools. In *Proceedings of the Committee on Assessing Genetic Risks, Institute of Medicine.* (In press.)

Micklos, D. Genetics Education in American Schools: A View From Cold Spring Harbor Laboratory. *Journal of the Swedish Seed Association* **102 (4):** December 1992.

Sites of Major 3- to 10-Day Workshops 1985–1992

ALABAMA	University of Alabama, Tuscaloosa	1987,1988,1989,1990
ARIZONA	Tuba City High School	1988
ARKANSAS	Henderson State University, Arkadelphia	1992
CALIFORNIA	University of California, Davis	1986
	University of California, San Francisco	**1991**
CONNECTICUT	Choate Rosemary Hall, Wallingford	1987
FLORIDA	North Miami Beach Senior High School	1991
	University of Western Florida, Pensacola	1991
	Armwood Senior High School, Tampa	1991
GEORGIA	Fernbank, Inc., Atlanta	1989
	Morehouse College, Atlanta	**1991**
HAWAII	Kamehameha Secondary School, Honolulu	1990
ILLINOIS	Argonne National Laboratory, Chicago	1986, 1987
	University of Chicago	**1992**
INDIANA	Butler University, Indianapolis	1987
IOWA	Drake University, Des Moines	1987
KENTUCKY	Murray State University	1988
	University of Kentucky, Bowling Green	1992
	Western Kentucky University	1992
LOUISIANA	Jefferson Parish Public Schools, Harvey	1990
MANITOBA	Red River Community College, Winnipeg	1989
MARYLAND	Annapolis Senior High School	1989
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools	1990,1991,1992
	St. John's College, Annapolis	*1991*
MASSACHUSETTS	Beverly High School	1986
	Dover-Sherborn High School, Dover	1989
	Randolph High School	1988
	Winsor School, Boston	1987
MICHIGAN	Athens High School, Troy	1989
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990,1991
MISSOURI	Washington University, St. Louis	1989
NEW HAMPSHIRE	St. Paul's School, Concord	1986,1987
NEVADA	University of Nevada, Reno	1992
NEW YORK	Albany High School	1987
	Bronx High School of Science	1987
	Cold Spring Harbor High School	1985,1987
	DeWitt Middle School, Ithaca	*1991*
	DNA Learning Center	1988(3),1989(2),1990(2), 1991, 1992
	DNA Learning Center	**1990, 1992**
	DNA Learning Center	*1990,1991,1992*
	Fostertown School, Newburgh	*1991*
	Huntington High School	1986
	Irvington High School	1986
	Junior High School 263, Brooklyn	*1991*
	Lindenhurst Junior High School	*1991*

Key: High School Workshops, **College Workshops**, and *Middle School Workshops*

	Orchard Park School, Orchard Park	*1991*
	Plainview-Old Bethpage Middle School, Plainview	*1991*
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987,1988,1989,1990
	Titusville Middle School, Poughkeepsie	*1991*
	Wheatley School, Old Westbury	1985
NORTH CAROLINA	North Carolina School of Science, Durham	1987
OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	North Westerville High School	1990
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy, Fort Washington	1988
PUERTO RICO	University of Puerto Rico, Mayaguez	1992
	University of Puerto Rico, Mayaguez	**1992**
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
VERMONT	University of Vermont, Burlington	1989
VIRGINIA	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
WASHINGTON, DC	**Howard University**	**1992**
WEST VIRGINIA	Bethany College	1989
WISCONSIN	Marquette University, Milwaukee	1986,1987
	University of Wisconsin, Madison	1988,1989
WYOMING	University of Wyoming, Laramie	1991

1992 Workshops, Meetings, and Collaborations

January 7–8	Site visit by Svalovs Kommun Delegation (Sweden)
January 14	Student Workshop, A. Philip Randolph High School, Harlem, New York
January 16	Grant review, William Patterson College, Wayne, New Jersey
January 18–19	National Science Foundation High School Faculty Workshop, Miami, Florida
January 25	Congressional Aides Workshop
January 25–26	National Science Foundation High School Faculty Workshop, Tampa, Florida
February 2–3	National Research Council Committee Meeting, Washington, DC
February 3–March 3	Site visit by Paola Melis of Porto Conte Research and Training Laboratories, Sardinia, Italy
February 5	Site visit by Jackie Grennon Brooks of SUNY, Stony Brook
February 8–9	National Science Foundation Middle School Faculty Workshop, Annapolis, Maryland
February 15–16	National Science Foundation College Faculty Workshop, San Francisco, California
February 21–23	Seminar, Coalition for Education in the Life Sciences Meeting, Racine, Wisconsin
February 23–26	Department of Energy Opinion Leaders Workshop
February 25	*Great Moments in DNA Science* Student Lecture
February 29–March 1	National Science Foundation College Faculty Workshop
March 11	*Great Moments in DNA Science* Student Lecture
March 15–21	National Research Council Committee Meeting, Irvine, California
March 17	*Great Moments in DNA Science* Student Lecture
March 25	Middle School Faculty Workshop
March 26	*Great Moments in DNA Science* Student Lecture
March 26–28	Workshop, National Association of Biology Teachers Meeting, Boston, Massachusetts
March 30–April 11	"Week of Scientific Culture" Exhibit, Sardinia, Italy
April 1–8	Site visit by Kerry and Bev Clarke, Australia
April 11	Cold Spring Harbor Laboratory Association Workshop
April 11	Congressional Aides Workshop
April 15	Corporate Advisory Board Meeting and Reception
April 21–24	Consultation, Carolina Biological Supply Company, Burlington, North Carolina
April 29	Lecture for Kiwanis of Long Island, Northport
May 6	Grant review, William Patterson College, Wayne, New Jersey
May 6–7	National Science Foundation Middle School Faculty Workshop, Howard County, Maryland
May 7	Lecture, Suffolk County Organization for Promotion of Education
May 27–29	Multi-Media Expo, New York
May 25–June 5	National Science Foundation College Faculty Workshop, University of Puerto Rico, Mayaguez
June 6–7	Middle School Faculty Workshop
June 8-12	National Science Foundation High School Faculty Workshop, University of Puerto Rico, Mayaguez
June 22–July 3	Department of Education College Faculty Workshop, Howard University, Washington, DC
June 22–26	Howard Hughes Medical Institute High School Faculty Workshop, Montgomery County, Maryland
June 23–25	National Science Foundation Middle School Faculty Workshop, Baltimore County, Maryland
June 24–26	National Science Foundation Middle School Faculty Workshop, Frederick County, Maryland

June 29–July 3	National Science Foundation High School Faculty Workshop, Henderson State University, Arkadelphia, Arkansas
June 29–July 3	*Fun With DNA* Student Summer Camp
June 29–July 3	Site visit by Fred Gillam, Sachem High School
July 6–12	*Fun With DNA* Student Summer Camp
July 9–10	High School Faculty Workshop, University of Central Arkansas, Conway
July 13	Grant review, New York Hall of Science, Queens
July 13–17	National Science Foundation High School Workshop, University of Western Kentucky, Bowling Green
July 13–19	*Fun With DNA* Student Summer Camp
July 20–24	National Science Foundation High School Faculty Workshop, University of Kentucky, Lexington
July 21–23	National Science Foundation Middle School Faculty Workshop, Anne Arundel County, Maryland
July 27–August 7	National Science Foundation College Faculty Workshop, Cold Spring Harbor
August 3–7	National Science Foundation High School Faculty Workshop, University of Nevada, Reno
August 3–7	*Fun With DNA* Minority Student Summer Camp
August 10–14	*Fun With DNA* Minority Student Summer Camp
August 10–21	Department of Education College Faculty Workshop, University of Chicago
August 11–13	National Research Council Committee Meeting, Woods Hole, Massachusetts
August 11–13	National Science Foundation Middle School Workshop, Anne Arundel County, Maryland
August 17–21	*Fun With DNA* Minority Student Summer Camp
August 18–20	National Science Foundation Middle School Faculty Workshop, Cecil County, Maryland
August 24–28	High School Student/Faculty Workshop
September 4	National Science Foundation Middle School Faculty Workshop, Ithaca, New York
September 25–27	*Winding Your Way Through DNA* Conference, San Francisco, California
October 12–16	"Gene Vision" Exhibit, Svalov, Sweden
October 16–18	Department of Education Meeting, Washington, DC
October 28–Nov 1	Site visit by Cindy Kelleher, University of California, San Francisco
October 31	Baring Brothers Workshop
November 1	Corporate Advisory Board Presentation and Dinner
November 3	Student Workshop, Valley Stream High School
November 7–8	National Science Foundation High School Faculty Workshop, University of Kentucky, Lexington
November 14	Lecture, Long Island Museum Association Meeting
November 14–15	National Science Foundation High School Faculty Workshop, Western Kentucky University, Bowling Green
November 14–15	Middle School Minority Faculty Workshop
November 19	Workshop, National Association of Science Teachers Meeting, New York
November 21–22	National Science Foundation Faculty Workshop, Henderson State University, Arkadelphia, Arkansas
December 5–8	Department of Energy Opinion Leaders Workshop

DNA LEARNING CENTER

Grantor	*Program/Principal Investigator*	*Duration of Grant*	*Total Award*
FEDERAL GRANTS			
NATIONAL SCIENCE FOUNDATION			
	High School Faculty Enhancement	1990–1993	489,036
	Middle School Faculty Enhancement	1990–1993	252,614
	College Faculty Enhancement	1991–1993	264,467
U.S. DEPARTMENT OF EDUCATION			
	College Faculty Enhancement	1991–1993	170,033
NONFEDERAL GRANTS			
Cablevision Systems Corporation	Capital Support	1992	250,000*
Stone Foundation	Program Support	1991–1994	250,000
Howard Hughes Medical Institute	High School Faculty Enhancement	1990–1993	46,500
Henderson State University	High School Faculty Enhancement	1992	2,472*
University of Kentucky, Lexington	High School Faculty Enhancement	1992	2,240*
University of Nevada, Reno	High School Faculty Enhancement	1992	2,835*
Abell Foundation	Minority and Special Programs	1992	2,100*
Barker Welfare Foundation	Minority and Special Programs	1992	5,000*
Brinkmann Instruments	Minority and Special Programs	1992	1,000
Corporate Advisory Board	Minority and Special Programs	1992	14,500*
Harweb Foundation	Minority and Special Programs	1992	2,000*
Laurie Landeau	Minority and Special Programs	1992	4,000
Life Technologies	Minority and Special Programs	1992	500
SUNY at Stony Brook	Minority and Special Programs	1992	10,000*
Edwin S. Webster Foundation	Minority and Special Programs	1992	15,000
Italian Ministry of Research	Exhibit Support	1992	45,450
The Weezie Foundation	Exhibit Support	1991–1992	100,000
New York State Legislature	Middle School Program	1992	50,000*
William Randolph Hearst Foundation	Middle School Program	1991–1994	100,000
Commack Union Free School District	Whole Learning Program	1992	5,000*
Half Hollow Hills Central School District	Whole Learning Program	1992	5,000*
Locust Valley Central School District	Whole Learning Program	1992	5,000*
Plainedge Union Free School District	Whole Learning Pogram	1992	5,000*
Commack Union Free School District	Curriculum Study	1992	500
East Williston Union Free School District	Curriculum Study	1992	500
Elwood Union Free School District	Curriculum Study	1992	2,000*
Garden City Union Free School District	Curriculum Study	1992	500
Great Neck Public Schools	Curriculum Study	1992	500
Half Hollow Hills Central School District	Curriculum Study	1992	500
Harborfields Central School District	Curriculum Study	1992	500
Herricks Union Free School District	Curriculum Study	1992	500
Island Trees Union Free School District	Curriculum Study	1992	500
Jericho Union Free School District	Curriculum Study	1992	500
Kings Park Central School District	Curriculum Study	1992	500
Lawrence Union Free School District	Curriculum Study	1992	500
Lindenhurst Union Free School District	Curriculum Study	1992	500
Locust Valley Central School District	Curriculum Study	1992	500
Manhasset Union Free School District	Curriculum Study	1992	500
Massapequa Union Free School District	Curriculum Study	1992	1,500

* New Grants Awarded in 1992

Grantor	*Program/Principal Investigator*	*Duration of Grant*	*Total Award*
Northport-East Northport Union Free School District	Curriculum Study	1992	500
North Shore Central School District	Curriculum Study	1992	500
Oyster Bay-East Norwich Central School District	Curriculum Study	1992	500
Plainview-Old Bethpage Central School District	Curriculum Study	1992	500
Plainedge Union Free School District	Curriculum Study	1992	500
Portledge School	Curriculum Study	1992	500
Port Washington Union Free School District	Curriculum Study	1992	500
Roslyn Public Schools	Curriculum Study	1992	500
Sachem Central School District at Holbrook	Curriculum Study	1992	500
South Huntington Union Free School District	Curriculum Study	1992	500
Syosset Central School District	Curriculum Study	1992	500

* New Grants Awarded in 1992