

# DNA Literacy Program

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The techniques of "gene splicing" have revolutionized biology over the last 15 years and have spawned the new biotechnology industry. The manifold economic and social implications of the increasing ability to manipulate the DNA blueprint of life appear regularly on the front pages of the nations' newspapers. Even so, there is abundant evidence that we are a nation of biotechnological illiterates. Recent studies show that a majority of Americans have little understanding of DNA and claim not to have heard of biotechnology!

The DNA Literacy Program was founded in 1985 to improve this situation by retraining science teachers nationwide so that they can better prepare students for the biotechnological world they will inherit. We see our mission as threefold:

1. To serve as a direct interface between science and society by translating current research into learning experiences for the general public.
2. To directly adapt research protocols so that they can be safely performed by students at the college and advanced high school levels.
3. To serve as a national clearinghouse for distribution of information about genetics and biotechnology to the general public.



A Japanese exchange student (left) and his lab partner from East Hampton High School participate in a student laboratory on bacterial transformation at the DNA Learning Center.

DNA Literacy Program Director David Micklos (left), summer intern Jeff Diamond, and Dr. Greg Freyer of Columbia University College of Physicians & Surgeons with the Vector Mobile DNA Laboratories in front of Jones Laboratory.



### **DNA Science Workshops**

The most visible aspect of our education program has been the Vector DNA Science Workshop, which has now been taken by more than 600 high school and college educators from New York to California, and from Wisconsin to Alabama. The week-long course gives teachers practical experience with recombinant-DNA techniques, bolstering confidence to integrate more discussion of biotechnology into their classrooms and addressing the practical aspects of implementing DNA labs. All equipment and supplies needed to teach the course are carried in a specially designed Vector Van, which was provided through a 1986 grant from Citibank, N.A. In summers 1985 and 1986, a total of 250 educators attended eight workshops. Demand for courses in summer 1987 was great enough to justify the purchase of a second Vector Van that enables us to teach two workshops simultaneously in different parts of the country. In summer 1987, 370 educators attended 14 Vector Workshops around the country. Two additional workshops were conducted for technicians and researchers at the Cleveland Clinic. In summer 1988, the Vector Vans will visit 12 new venues, including a Navajo Indian reservation at Tuba City, Arizona.

### **Major Three-Year Support**

Receipt in 1987 of major three-year grants from the Josiah Macy, Jr. Foundation (\$490,850) and the National Science Foundation (\$451,928) has lent legitimacy to the proposition that it is possible to "backpack" a DNA laboratory to essentially anywhere in the nation. These grants provide key support for our teaching staff, as well as stipend and travel expenses for workshop participants. They also provide funds to hold weekend follow-ups during the fall and winter to introduce new innovations that make it easier and more cost-effective to teach biotechnology in the high school classroom. More than 225 teachers attended the 12 follow-up workshops, and the response of participants was overwhelmingly favorable.

Participants who successfully complete both a summer workshop and a weekend follow-up receive an intense 50 hours of instruction. Through a collaboration with the State University of New York at Stony Brook, these individuals are eligible to receive three hours of graduate credit from the Continuing Education Department.

### **Collaboration with Carolina Biological Supply Company**

As our teaching program grew and teachers in many areas began to adopt our laboratory methods, it became clear that we needed to identify a company with the capability to distribute equipment and reagents to teachers who wished to implement lab-teaching programs. Thus, in late 1986, we signed a cooperative agreement with Carolina Biological Supply Company, one of the nation's oldest and most respected science suppliers. In 1987, we collaborated with their biotechnology department to develop reagents and kits that articulate fully with our laboratory text, *DNA Science: A First Laboratory Course in Recombinant-DNA Technology*. We also assisted in the design and evaluation of an inexpensive power supply and an electrophoresis chamber. These apparatuses, which are used to produce DNA "fingerprints," are key to introducing DNA science in the classroom.

### **DNA Learning Center**

The Macy and NSF support, along with continuing grants from a consortium of private foundations and biotechnology companies, emboldened us to put into action our dreams for a "museum" devoted entirely to helping the general public understand the DNA blueprint that determines the life and health of all living things. Thus, we concluded negotiations with the Cold Spring Harbor Central School District for the long-term lease, with purchase option, of the former grade school building at 334 Main Street in Cold Spring Harbor Village.

Considering the magnitude of the Laboratory's commitment, a trustee advisory committee was formed to assume fiduciary responsibility for the Learning Center. Chaired by William Everdell, the committee includes Mrs. Henry U. Harris, Jr., Mrs. George N. Lindsay, Dr. David Botstein, Dr. David D. Sabatini, Byam K. Stevens, Jr., and Mrs. George G. Montgomery, Jr.

The trustees of the Laboratory showed strong support for the Center by approving a capital budget of \$158,000 for Phase I renovations. Offices were prepared for a permanent staff of four, and computer, telephone, and fire/security systems were installed. We are most pleased with the teaching laboratory, which we consider the heart of our institution. Designed to accommodate 24-27 participants, the laboratory provides an environment where young people and the lay public can learn science in the same way as scientists, by asking questions and performing experiments.



Dr. Mark Bloom instructs high school students at the DNA Learning Center.

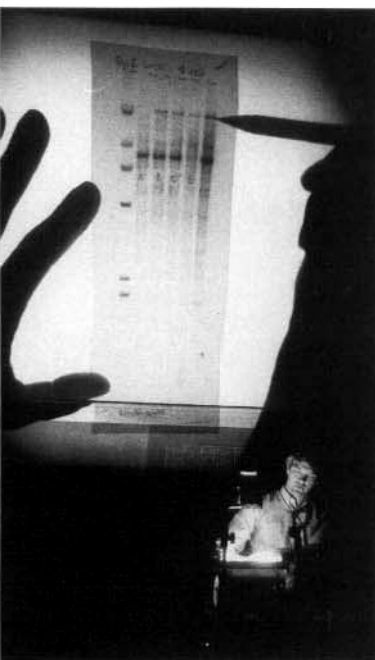
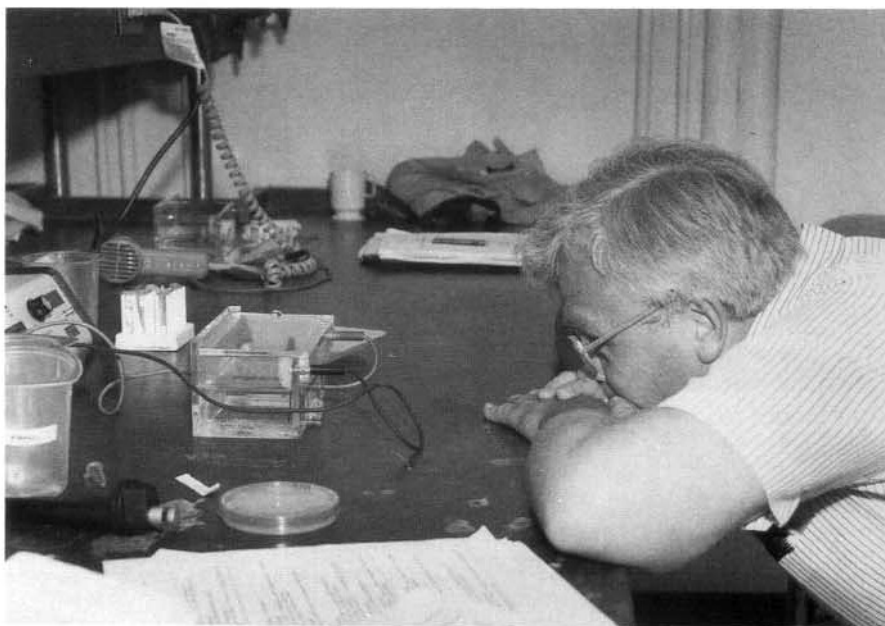
## Student Laboratory Field Trips

With the completion of the teaching laboratory, we initiated a schedule of six hands-on laboratories per week for high school students from the Metropolitan New York area. Two laboratory experiences introduce the key techniques of gene manipulation:

1. *Bacterial Transformation*. This experiment illustrates the direct link between an organism's genetic complement (genotype) and its observable characteristics (phenotype). Students introduce a new gene into the bacterium *Escherichia coli*, giving it the ability to grow in the presence of the antibiotic ampicillin.
2. *DNA Fingerprinting*. This experiment demonstrates that DNA can be precisely manipulated and that it behaves as predicted by the structure determined by James Watson and Francis Crick in 1953. Students use restriction enzymes to cut purified DNA, and the resulting DNA fragments are analyzed by gel electrophoresis. Students take home Polaroid snapshots of their results.

Response to this new program has been overwhelming. Within three weeks following the announcement of the opening of the teaching lab, our entire spring schedule was booked with 50 class visits.

Raymond Fleischmann (right) from Walt Whitman High School separates DNA fragments using electrophoresis at a week-long teacher workshop at SUNY, Stony Brook. Dr. Jan Witkowski (below) of Cold Spring Harbor Laboratory explains the use of gene probes in diagnosing muscular dystrophy at an honors lecture for local students.



## Local Curriculum Study Grows

The DNA Literacy Program arose out of an initial collaboration with science educators in eight neighboring school districts. Using Long Island schools as a proving ground, we developed and tested our lab-teaching programs and workshop methods. The program has now grown to include 20 school districts, which benefit from enhancement activities that include teacher in-service training, honors lectures for students, student research symposia, free and reduced-rate student visits to the Learning Center, and lab-teaching consultation.



The Smithsonian Institution's *Search for Life* exhibit highlights the accomplishments of four Cold Spring Harbor scientists, including Laboratory Director James D. Watson (far left) and Dr. Barbara McClintock (below).

### The Search for Life Exhibit

During the past year, the Laboratory cooperated with The National Museum of American History of the Smithsonian Institution and the Maryland Agricultural Experiment Station in the development of their new exhibit, *The Search for Life*, by supplying historical artifacts, photographs, and video footage. The largest and most up-to-date museum exhibit on modern biology in the United States, *The Search for Life* traces the quest to understand the genetic and molecular basis of life, which culminated in the recombinant-DNA revolution. The exhibit also confronts the visitor with the promise and the controversy of our increasing ability to manipulate the genetic code. Key discoveries of four Cold Spring Harbor staff members are specifically highlighted.

We were thus delighted when, in early 1988, we concluded an agreement to have the DNA Learning Center as the first site of a national tour of the exhibit. *The Search for Life* will open at Cold Spring Harbor in September 1988 and run through September 1989. The Smithsonian exhibit represents a rare opportunity to accelerate the development of the DNA Learning Center, allowing it to burst into existence with a powerful education program. The prospect of learning the museum business from the nation's preeminent museum is most exciting.

The 2500-square-foot exhibit was developed in collaboration with New York City theater designers, who utilized historical artifacts, video monitors, interactive displays, and a three-screen slide show within a futuristic "set" composed of aluminum girders whose latticework suggests the DNA helix. The entire program, including narration and theatrical lighting used to guide the visitor through the exhibit, is computer-controlled.

The exhibit will be situated adjacent to the teaching laboratory, where visitors can perform hands-on experiments or view daily demonstrations. Since Smithsonian curators had originally hoped to include live demonstrations in the exhibit, the Learning Center staff has agreed to train subsequent exhibit hosts in appropriate hands-on lab activities. In addition, our staff has committed to develop educational materials to expand and interpret the information in *The Search for Life* exhibit. Pre- and post-trip packages and interpretive materials will be shared with subsequent exhibit hosts.

The exhibit will be seen by a significant number of research biologists who attend meetings and workshops at Cold Spring Harbor Laboratory. Their suggestions and help will be incorporated into a renovation of the exhibit prior to its shipment to subsequent tour sites. Input from visiting scientists will also be of help in developing our own exhibit, *DNA at Work*, to follow on the heels of the Smithsonian exhibit.



## Staff Members and Interns

We were most lucky to coax Dr. Mark Bloom to take on responsibility for the lab-training aspects of the DNA Literacy Program. With graduate training in biology and experience as a research molecular biologist at the Roche Institute and Michigan State University, he provides authority to our advice to teachers and insurance that our programs will continue to focus on real science. Joining us in June, he was thrown into the fray of summer activity, teaching 8 of 14 workshops.

Dr. Greg Freyer, who helped found the program and who worked on development of our protocols while a postdoctoral fellow at Cold Spring Harbor Laboratory, is currently an assistant professor at Columbia University College of Physicians and Surgeons. Greg continues to provide research support to our program and has just completed development of plasmid vectors used in our workshop program. To our knowledge, these are the first DNA molecules specifically developed for teaching purposes.



The DNA Literacy Program staff (from the left) Henri Dold, David Micklos, Nancy Baldwin, Mark Bloom, Cortney Armstrong, and John Kruper; (below) summer intern Jeff Mondschein.



Our summer interns, who lead the life of DNA gypsies traveling from workshop to workshop, continued to provide critical support for our teaching staff. Two were students from the neighboring high schools of Jericho and Sachem: Jeff Mondschein, now in his first year of pre-medical training at New York University, completed his second summer with the program, and Thomas Hyland, now a freshman at Rensselaer Polytechnic Institute. Undergraduate intern Jeff Diamond is now completing his junior year in biomedical engineering at Duke University.

Since we consider ourselves an academic unit, we were especially pleased to take on graduate student John Kruper, now working on a D.A. in molecular biology at the University of Illinois at Chicago. With previous training in virology, John is basing his thesis on evaluative data on teachers who have participated in our training workshops. During the winter, one Vector Van was stationed in Chicago with John, who taught four weekend follow-ups in the midwest.

Joining the permanent staff of the Learning Center in 1988, from other positions at the Laboratory, were Nancy Baldwin and Cortney Armstrong. Program Associate Henri Dold, who was among the first teachers in the nation to introduce DNA analysis at the high school level, assumed major responsibility for organizing our summer 1988 schedule of 12 Vector Workshops.

## Recalling our Heritage as a Teaching Center

The DNA Literacy Program recalls the founding of the Biological Laboratory at Cold Spring Harbor in 1890 as a summer field station where high school teachers could experience experimental aspects of biology that could not be learned from a textbook. With the opening of the DNA Learning Center, we are now well into the lead of DNA education, but there are few road maps to follow.

As keepers of the nation's first exploratorium of DNA, we are sometimes daunted by the operating costs of our rapidly expanding programs—approximately \$50,000 per month, including capital development of the Center. Facing similar needs when he assumed directorship of the Laboratory in 1968, Jim Watson said, "The Lab badly needs a real benefactor, but with much love it will probably survive without one. Of course, I dream an angel will appear soon and make me free of any serious worries for at least a month."

There is no time to tarry in working toward our goal to foster public understanding of the DNA revolution. As a small institution, we are prepared to accept a disproportionate share of the cost of educating the first generation of Americans who already dwell in a brave new world. It is a huge task, but the stakes of biotechnological illiteracy are too high.



Graduate intern John Kruper (left) interprets a DNA fingerprint for teachers at a local Curriculum Study workshop at Cold Spring Harbor High School.

## Vector Workshop Sites, 1985-88

Alabama	University of Alabama, Tuscaloosa	1987, 1988
Arizona	Tuba City High School, Tuba City	1988
California	University of California, Davis	1986
Connecticut	Choate Rosemary Hall, Wallingford	1987
Illinois	Argonne National Laboratory, Argonne	1986, 1987
Indiana	Butler University, Indianapolis	1987
Iowa	Drake University, Des Moines	1987
Kentucky	Murray State University, Murray	1988
Maryland	McDonough School, Baltimore	1988
Massachusetts	Beverly High School, Beverly	1986
	Randolph High School, Boston	1988
	Winsor School, Boston	1987
New Hampshire	St. Paul's School, Concord	1986, 1987
New York	Albany High School, Albany	1987
	Bronx High School of Science, The Bronx	1987
	Cold Spring Harbor High School, Cold Spring Harbor	1985, 1987
	DNA Learning Center, Cold Spring Harbor	1988
	Huntington High School, Huntington	1986
	Irvington High School, Irvington	1986
	S.U.N.Y., Stony Brook	1987, 1988
	Wheatley School, Old Westbury	1985
North Carolina	North Carolina School of Science and Math, Durham	1987
Ohio	Cleveland Clinic, Cleveland	1987
Pennsylvania	Dusquesne University, Pittsburgh	1988
	Germantown Academy, Philadelphia	1988
South Carolina	Medical University of South Carolina, Charleston	1988
	University of South Carolina, Columbia	1988
Virginia	Jefferson High School for Science, Alexandria	1987
Wisconsin	Marquette University, Milwaukee	1986, 1987



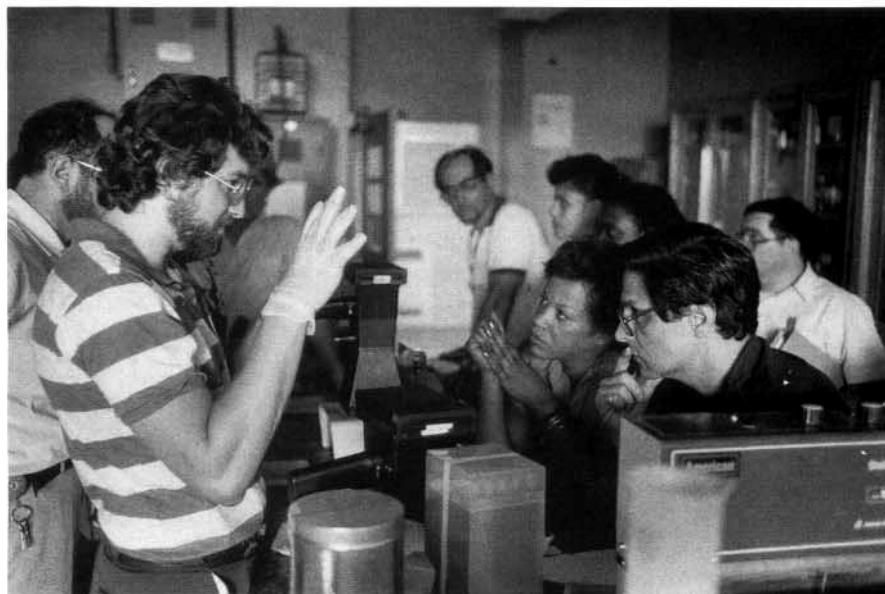
Teachers at a week-long workshop at SUNY, Stony Brook prepare a reaction to cut DNA with restriction enzymes.

### Curriculum Study Membership

- \*Cold Spring Harbor Central School District
- Commack Union Free School District
- \*East Williston Union Free School District
- \*Great Neck Public Schools
- Half Hollow Hills Central School District
- Harborfields Central School District
- \*Herricks Union Free School District
- Huntington Union Free School District
- \*Jericho Union Free School District
- Lawrence Public Schools
- Locust Valley Central School District
- Manhasset Public Schools
- \*Northport-East Northport Union Free School District
- North Shore Central School District
- \*Oyster Bay-East Norwich Central School District
- Plainview-Old Bethpage Central School District
- Portledge School
- Port Washington Union Free School District
- Sachem Central School District at Holbrook
- \*Syosset Central School District

\*Founding Member

Dr. Greg Freyer (left) with workshop participants at the Bronx High School of Science.





<i>Grantor</i>	<i>Program/Principal Investigator</i>	<i>Duration of Grant</i>	<i>Total Award</i>
<i>DNA Literacy Program</i>			
GIBCO/BRL Research Products division of Life Technologies Inc.	Core Program Support	1987	\$10,000*
J.M. Foundation	Core Program Support	1986-1987	60,000
Richard Lounsbery Foundation	Core Program Support	1987	15,000*
Josiah Macy, Jr. Foundation	Core Program Support	7/87- 6/90	490,850*
National Science Foundation	Core Program Support	6/87-11/90	451,928*
Brinkmann Instruments, Inc.	DNA Learning Center	1987	10,000*
Argonne National Laboratory Center for Biotechnology, SUNY Stony Brook	Vector Workshop Program	1987	1,421*
Cleveland Clinic Foundation	Vector Workshop Program	1987	11,130*
Fotodyne Incorporated	Vector Workshop Program	1987	16,784*
Eli Lilly and Company	Vector Workshop Program	1987	9,000*
Miller Brewing Company	Vector Workshop Program	1987	10,000*
North Carolina Biotechnology Center	Vector Workshop Program	1987	1,000*
Pioneer Hi-Bred International, Inc.	Vector Workshop Program	1987	500*
			9,038*
Cold Spring Harbor School District	Curriculum Study	1987	500*
Commack School District	Curriculum Study	1987	1,500*
East Williston School District	Curriculum Study	1987	500*
Great Neck School District	Curriculum Study	1987	500*
Half Hollow Hills School District	Curriculum Study	1987	3,000*
Harborfields School District	Curriculum Study	1987	4,000*
Herricks School District	Curriculum Study	1987	1,000*
Huntington School District	Curriculum Study	1987	1,500*
Jericho School District	Curriculum Study	1987	2,250*
Lawrence School District	Curriculum Study	1987	1,500*
Locust Valley School District	Curriculum Study	1987	2,000*
Manhasset School District	Curriculum Study	1987	1,500*
Northport-East Northport School District	Curriculum Study	1987	500*
North Shore School District	Curriculum Study	1987	1,500*
Oyster Bay-East Norwich School District	Curriculum Study	1987	500*
Plainview-Old Bethpage School District	Curriculum Study	1987	1,500*
Portledge School	Curriculum Study	1987	1,500*
Port Washington School District	Curriculum Study	1987	1,500*
Sachem School District	Curriculum Study	1987	1,500*
Syosset School District	Curriculum Study	1987	500*

\* New grants awarded in 1987