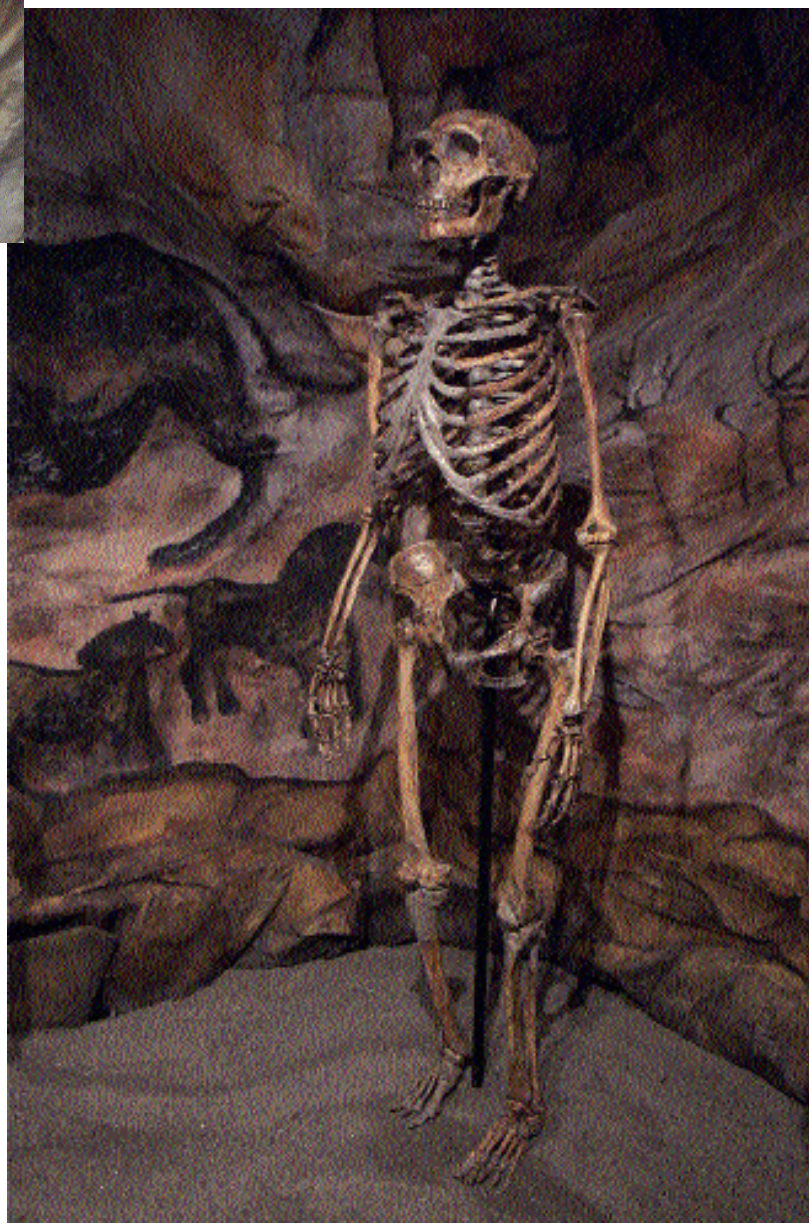
Dolan DNA Learning Center

2002 Annual Report



DOLAN DNA LEARNING CENTER

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With the entire human DNA sequence now "in the bag," ahead lies the task of translating this trove of information into healthier and happier lives. We still need to find the genes behind many common, chronic diseases that stealthily sap productivity and shorten lifespan—including asthma, noninsulin-dependent diabetes, schizophrenia, and bipolar disorder (manic depression). Each of these "complex" disorders appears to involve multiple genes whose expression is further modified by environmental factors. Thus, we cannot expect a single "magic bullet" to treat these diseases. Rather, different patients will require different treatments to counter the specific gene changes that are at the root of their illness.

Prescribing the right gene-based remedy may require a precision that is generally absent from medicine today. Everyone must have taken pause at the paradox of a physician asking us if we are allergic to a particular drug. After all, shouldn't the doctor be the one to inform us of a potential problem? Unfortunately, trial and error is the only way to determine a patient's response to many drugs—it takes an allergic reaction to know you are allergic! Thus, the endgame of genetic medicine is pharmacogenetics—predicting drug response and tailoring treatment to each person's genetic makeup.

The term "pharmacogenetics" was first coined in 1959 by Friedrich Vogel to describe inherited drug responses that vary between population groups. For example, some African American soldiers serving in Italy during World War II had severe reactions to the antimalaria drug primaquine. Later work showed that inherited defects in so-called metabolic enzymes—the cytochrome P450 monooxygenases (CPY450s)—are responsible for many adverse drug responses. In the liver, the CPY450 enzymes convert many drugs to their bioactive forms. It is estimated that mutations in CPY450 genes lead to poor or toxic metabolism of more than half of the common drugs—including albuterol, codeine derivatives, β-blockers, monoamine oxidase inhibitors, antihypertensives, tricyclic antidepressants, antipsychotics, neuroleptics, and Prozac—as well as a similar proportion of anticancer drugs. Prevalence of mutations in different CPY450 genes varies greatly, affecting as few as several percent of people in one population or as many as 20% in another.

Affymetrix produces a GeneChip® that can assess common mutations in all of the major CPY450 genes. However, until such assays become standard in medical care, people will continue to be guinea pigs in experiments with increasingly powerful drugs. This is especially troubling in the case of psychoactive drugs, whose improper metabolism can send patients even deeper into psychosis.

Each person's unique disease susceptibilities and responses to drugs are, in large part, the balance between our uniqueness as individuals and similarities we share with others in our historical population groups. Written in each person's DNA is a record of our shared ancestry and our species' struggle to populate the earth. Our ancient ancestors moved around, and eventually out of, Africa. They moved in small groups, following river valleys and coastlines, reaching Asia and Europe. Land bridges that appeared during recurring Ice Ages later allowed them to reach Australia and the Americas.

As these early people wandered, their DNA accumulated mutations. Some provided advantages that allowed these pioneers to adapt to new homes and ways of living. Others were nonessential. Mutations are the grist of evolution, producing gene and protein variations that have allowed humans to adapt to a variety of environments—and to become the most far-ranging mammal on the planet. The same mutational processes that generated human diversity—point mutations, insertions/deletions, transposition, and chromosome rearrangements—also generated disease.

It may be hard to see from our current vantage point, but the entire industrial revolution has occupied only about 0.1% of our 150,000-year history as a species. The cradles of western civilization—classical Greece and Rome—take us back into only 2% of our history. The earliest city-states of Mesopotamia, Babylonia, Assyria, and China take us back only 4% of the way into our past. At 7%, we reach the watershed of agriculture, which changed forever the way humans would live and work. After language, the domestication of plants and animals is the single greatest civilizing factor in human history. Increased production and performance of domesticated organisms made possible urbanization and task specialization in human society. Thus, the labor of fewer and fewer farmers produced enough food and clothing materials to satisfy the needs of growing numbers of nonfarmers—artisans, engineers, scribes, and merchants—freeing them to develop other elements of culture. Reaching back the remaining 93% of our history, to the dawn of the human species, we lived only as hunter-gatherers.

Throughout most of human history, the hunter-gatherer group was the basic population unit upon which evolution acted. These small populations were subject to the founder effect, inbreeding, and genetic drift (a random fluctuation of nonessential alleles). Over millennia, these effects join with selection to concentrate particular gene variations within different population groups. The fastest evolving part of our genome, the mitochondrial control region, accumulates about one new mutation every 20,000 years. Mutations are five- to tenfold less frequent in most regions of the nuclear chromosomes. Thus, virtually every gene in our genome is, on average, only one or two mutation events away from our hunter-gatherer heritage. Our genomes preserve the genetic residue of a time when all human beings lived in small, cohesive groups. Our basic anatomy, physiology, and many aspects of behavior are essentially identical to the hunter-gatherers who ranged through the ancient landscapes of Africa, Europe, Asia, Australia, and the Americas. These ideas can substantially broaden our understanding of the genetic basis and treatment of human disease.

Ancient humans of the species *Homo erectus* left Africa 1.7 million years ago, reaching Europe and Asia (dashed lines). Groups of *Homo sapiens* left Africa about 70,000 years ago (solid lines). These groups replaced any remaining ancient populations, reaching Asia and Australia about 60,000 years ago and entering Europe about 45,000 years ago.

Enabling Students to Explore Our Shared Genetic Heritage

Over the past four years, we have developed a unique program that allows students to use their own DNA as a starting point to investigate the related concepts of pharmacogenetics and human variation. Using a laboratory kit developed by the DNA Learning Center (DNALC) and distributed nationwide by the Carolina Biological Supply Company, students isolate DNA from hair roots or cheek cells. Their DNA is mixed with freeze-dried polymerase chain reaction (PCR) reagents to amplify (clone) a highly variable region of their mitochondrial genome. The amplified samples are then shipped to the DNALC, where student interns perform the final DNA sequencing reactions. In addition to our national program, we now offer DNA sequencing as a lab field trip for local school districts at both the Cold Spring Harbor DNALC and the DNALC *West* in Lake Success.

During the year, our *DNA Sequencing Service* processed over 3400 samples submitted by 95 high schools, 44 universities/colleges, and nine community colleges. As a testament to the growing popularity of this free service, the number of samples processed this year has grown over 70% from last year. DNA sequences are uploaded to the *Sequence Server* database on our *BioServers* WWW site, where they can be used to perform a number of analyses, including BLAST searches and CLUSTAL sequence alignments. The curriculum focuses on evolutionary comparisons with other students' DNA, modern human DNA from around the world, ancient human DNA, and Neandertal DNA. Visits to the *BioServers* WWW site tripled from 30,332 in 2001 to 89,677 in 2002.

We are grateful to Frank Stephenson at Applied Biosystems for allowing the DNALC to increase the size of our program while continuing to provide the service free of charge. Applied Biosystems provides costly experimental reagents and critical technical assistance for maintaining our ABI 377 DNA sequencing machine. Lori Grady and Jodi Barditch in Tim Tully's lab and Ray Preston at the CSHL Cancer Genome Research Center provide technical support for the program.

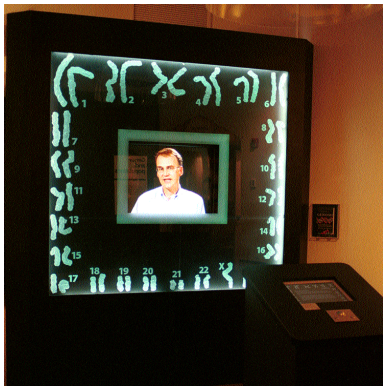
The ABI 377 DNA sequencer is a working exhibit at the DNALC.

The Genes We Share

In September, we launched our tribute to the Human Genome Project, a new exhibition entitled *The Genes We Share*. The 2000-square-foot exhibit takes a global look at the incredible genetic similarity of all human beings, as well as the differences that make each person unique. Visitors are encouraged to view the human genome as a record of our shared ancestry, an instruction manual for our bodies, and a source of information that can foreshadow a person's future health.

In our main hall, visitors have the opportunity to look at their similarities and differences on both an individual and a population level. An interactive area encourages visitors to compare characteristics that make them unique—such as tongue-rolling ability, hairiness, eye color, and other physical traits. Shifting focus even closer, microscopic footage and high-resolution animations have been used to highlight the body structures and biological processes that we all share. DNA and personality profiles of identical twins from Long Island, Matt and Danny, explore the relationship between nature (DNA) and nurture (environment).

After this personal view, the focus shifts to the level of human populations and how genetic differences have evolved between them. A wall-sized, interactive world map depicts the migration paths of our earliest ancestors and illustrates some of the environmental factors that influenced human evolution. An interactive table in the shape of a mitochondrion allows visitors to explore the use of DNA to study human evolution and trace our ancestry. An adjacent gallery is given over to a recreation of a Paleolithic cave in southern Europe. Here, skeletons of a chimpanzee, modern human, and Neandertal



The Genes We Share exhibition.

encourage visitors to consider the genetic and anatomical changes that set humans apart from other primates. Prehistoric paintings, as well as Neandertal and Cro-Magnon burials, encourage visitors to think about the earliest evidence of unique human behaviors and self awareness.

The interpretation of the human DNA sequence is introduced by an interactive exhibit, "Stories in Our Genes," in which Matt Ridley presents a guided tour through the human chromosomes—based on his popular book, *Genome: Autobiography of a Species in 24 Chapters*. An eight-foot-tall adaptation of the original metal DNA model constructed in 1953 by Francis Crick and James Watson represents the beginning of our quest to understand the "book of life." A working DNA sequencer, operating daily to sequence the DNA submitted by student classes from around the United States, illustrates more recent advances in DNA technology. Finally, exhibits on DNA "chips" and gene therapy give the visitor an opportunity to ponder how DNA will impact their future lives and health.

The exhibit received notable visitors in 2002, including Prince Andrew, the Duke of York, and the actor William Hurt. In October, scientists attending the *Human Origins and Disease* meeting at Cold Spring Harbor Laboratory visited the exhibit, and were particularly keen to see the Neandertal skeleton reconstruction, the first ever displayed in any museum. Experts included Dr. Chris Stringer from the Natural History Museum in London, and Dr. Svante Pääbo, whose team isolated the first DNA from ancient Neandertal bones. Funding for *The Genes We Share* was provided by the Richard Lounsbery Foundation, The William A. Haseltine Foundation for Medical Sciences and the Arts, Tularik Inc., and Laurie J. Landeau, V.M.D.

DNA Interactive for DNA's 50th Birthday

As part of the many activities that will mark the 50th anniversary of the discovery of the structure of DNA, the DNALC took on the challenge of developing a WWW site to parallel a five-part television series, *DNA: The Secret of Life*, due to air in spring 2003. The WWW site, *DNA Interactive (DNAi)*, is

funded by a grant from the Howard Hughes Medical Institute. DNAi offers visitors a unique multimedia resource through which to learn about the history and impact of DNA science.

www.dnai.org

Many of the 18 instructional modules in *DNAi* make use of a "4-P" structure, which allows students to "discover" key principles of DNA science. ***P**roblem* introduces the question at hand and provides key background information. ***P**layers* uses video clips to introduce the views and approaches of the principal scientists working on the problem. ***P**ieces of the Puzzle* uses animations to illustrate experiments that provide clues to solving the problem. ***P**utting It Together* uses animations, videos, and/or interactive games to synthesize the answers to the problem.

By far the most ambitious project yet attempted by our *BioMedia* Group, the site incorporates over five hours of video footage gleaned from interviews with over 70 scientists—including ten Nobel Laureates. More than 150 animations illuminate key experiments in the history of DNA and bring to life the molecular processes that govern DNA replication and expression. A ten-person team at the DNALC coordinated with producers at the Walter and Eliza Hall Institute in Melbourne, Australia, and at three companies in London (Windfall Films, RGB Post, and The Mill). The Mill won an Academy Award for visual effects in *Gladiator* and is noted for creating much of the wizardly magic in the Harry Potter movies.

DNAi is built using Flash MX, an integrated WWW platform released by Macromedia in summer 2002. Flash MX gives us the flexibility to easily integrate different media types—text, animations, and video—into a unified page design. Flash MX has the great advantage of playing its own formatted video files, allowing for seamless integration of a video player into the web page itself. Thus, the *DNAi* site requires a single plug-in, Flash 6, for both animation and video playback, without the need for an additional RealPlayer or Quicktime plug-in. We also developed a video window that incorporates a scrollable caption—aiding the hearing-impaired, improving intelligibility of speakers, and allowing quotations to be cut and pasted into word processing documents.

Although it employs the latest technology, the site provides a satisfying multimedia experience for broadband and dial-up users alike. We devoted considerable effort to optimizing file size and video compression to minimize loading time and provide improved performance compared to sites of similar complexity. Flash formatting allowed us to achieve 100-fold compression of video files—with surprisingly little loss of quality. The video player provides three viewing options, which ensures smooth operation for all users. At an average dial-up speed of 40 kbps, the largest pages and multimedia files load in a maximum of 30 seconds, with smaller files loading in 15 seconds or less.

The site will also include a *Lesson Builder* that will allow teachers to build their own multimedia "power point"-style presentation using resources from the *DNAi* WWW site. All animations, videos, photos, and narratives will be keyword-tagged and accessioned in a database. Registered teachers then can use keywords to search the database for items of interest. After previewing material generated by the search, a lesson is created simply by dragging the desired items into a linear "filmstrip." Each lesson is stored under a teacher's profile, and a URL of the lesson can be shared with fellow teachers or students in a class.

Conclusion of Five Years of Macy Support

In the fall, we completed the final year of a five-year program to develop the companion WWW sites *DNA from the Beginning* (*DNAFTB*, http://www.dnaftb.org) and *Your Genes, Your Health* (*YGYH*, http://www.ygyh.org). These sites are specifically designed to provide students and families with the

www.dnaftb.org

www.ygyh.org

basic information they need to understand the science behind genetic disorders. Visitors to these popular sites doubled, from 804,296 in 2001 to 1.67 million in 2002.

In funding this project, the Josiah Macy, Jr. Foundation helped establish our *Biomedia* Group, a multidisciplinary team of science, communication, and design professionals. The program was among the first initiated by June Osborn, when she became Macy Foundation President after serving as Dean of the School of Public Health at the University of Michigan. Macy chairman Clarence Michalis and board member David Luke were also instrumental in a 1987 grant, which helped establish the DNALC's instructional programs.

DNAFTB was completed in November 2000 and is currently the first site listed on a search for "DNA" using Google, the web's most popular search engine. The site is organized around 41 key concepts that span one and a half centuries, beginning with basic principles of Mendelian genetics (1865) and ending with current techniques on targeted gene knockouts. The work of over 90 scientists, including 32 Nobel Laureates, is highlighted in animations and interviews.

In November 2001, we produced a CD-ROM that makes *DNAFTB* available to a much broader audience—allowing those who lack an Internet connection to use the work at school or at home, as well as providing quick operation and full-motion video to those with slow Internet connections. Sales of the CD-ROM have generated enough income to consider producing other-language *DNAFTB* CD-ROMs and *YGYH* CD-ROMs. *DNAFTB* is currently being translated into three languages: German, Traditional Chinese, and Icelandic. These translated versions will be mirrored here at the DNALC, as well as hosted at the German, Taiwanese, and Icelandic sites.

YGYH was completed in November 2002. The site is specifically targeted at patients and families who are looking for understandable information about a specific genetic disorder. *YGYH* is organized according to questions visitors may have about the disorder: What is it? What causes it? How is it inherited? How is it diagnosed? How is it treated? What is it like to have it? Where can I get more information?

The site focuses on 15 disorders, which were chosen using three criteria: high incidence rate, known genetic cause, and severity of the phenotype (symptoms). In each case, we enlisted the participation of the genetic foundation or organization for information and access to patients and/or physicians for video interviews. Each disorder comprises a number of resource pages that provide in-depth information. The first "page" provides quick facts for casual browsing. Subsequent pages include detailed animations to help visitors visualize the unseen world of genes and molecules and explain the biology of the disorder. Video interviews with researchers and patients provide insiders' views on genetic disorders. Links help users find support groups and additional information.

Eugenics Image Archive

www.eugenicsarchive.org

The *Image Archive on the American Eugenics Movement* web site continues to be a popular resource for students and faculty alike. In 2002, the *Archive* received 187,263 visitors, more than double the visits in the previous year.

Early in the year, we set to the task of editing the 1000 new images collected in the United States and England since the launch of the site in February, 2000. At a May meeting, the working group of Steve Selden, Gar Allen, Elof Carlson, and Paul Lombardo helped prepare the captions for the completed images. Pending final edits, these new images should become available in spring 2003. Additional images were collected during a visit to the Max Planck Society Historical Archives in Berlin, Germany—including images of Otmar Freiherr von Verschuer and his twin studies.

The working group, along with Barbara Biesecker (National Human Genome Research Institute) and David Goldman (National Institutes of Health), contributed their expertise by speaking in May at the second of three Banbury meetings, *American Eugenics and the New Biology: Perspectives and Parallels*. This meeting aims to familiarize "opinion leaders" about this dark saga in American science. The meeting drew 26 participants from diverse fields, including family genetics, education, ethics, journalism, government, industry, and philanthropy. The third of the Banbury meetings will be held in 2003.

May 2, 2002 marked an important date in eugenics history: the 75th anniversary of the Supreme Court decision that upheld the concept of eugenic sterilization for people considered genetically "unfit." This famous court case, "Buck *v.* Bell," was the focus of a feature article that was included on the *Archive* web site as well as on *Gene Almanac*. In the fall, we began production on a multimedia module to provide an in-depth look at the Buck v. Bell case. Here, we enlisted extensive help from our friend Paul Lombardo, a legal historian who has devoted his career to unraveling the truth behind Buck *v.* Bell. With a PBS film crew, we followed Paul on a virtual "pilgrimage" of key sites in the Buck *v.* Bell story: the Virginia Colony for the Epileptic and Feeble Minded, in Lynchburg, where protagonist Carrie Buck and her mother Emma were incarcerated; the Amherst County Court House, where the case was first heard, before going to the U.S. Supreme Court; and the Venable School, in Charlottesville, where Carrie's child Vivian was a solid student before her early death. Dr. Lombardo's analysis of this nadir in U.S. jurisprudence was filmed against the backdrop of the rotunda of the University of Virginia, designed by Thomas Jefferson, and widely considered a symbol of the American dream for human rights. Clips from the interviews will be featured at the *Eugenics Archive* and on the new *DNA Interactive* site.

Inside Cancer

Inside Cancer, funded by the National Institutes of Health, Science Education Partnerships Award (SEPA) program, is a multimedia web site under development that is geared toward the general public, especially teachers and students. It will be a resource for people who want authoritative information on the workings of a cancer cell. Animations and video interviews with cancer researchers and other experts will help people understand the complex science and issues of cancer.

Coming in 2003.

Inside Cancer will feature five modules: *What Is Cancer?* emphasizes cancer as a disease and shows how cancers develop from a single cell; *Causes & Prevention* identifies behaviors and environmental factors that increase cancer incidence; *Diagnosis & Treatment* shows how oncologists diagnose cancers, the types of treatment options available, and how they work; *Cancer in the Laboratory* introduces major cancer researchers and the importance of their discoveries; *Pathways to Cancer* is a three-dimensional tour of a cell that focuses on the signaling pathway. Disruption of the pathway can lead to irregular cell growth and cancer. Each module is subdivided into an Overview and relevant content segments. The Overview will be the "highlight reel," and will introduce visitors to more in-depth content.

Major development effort has focused on creating high-resolution, three-dimensional animations of a cell's signaling pathway for the *Pathways to Cancer* module. A pathway initiated by platelet-derived growth factor (PDGF) was chosen because it provides an opportunity to illustrate the key points at which cellular growth control can be lost during oncogenesis. The importance of protein products of proto-oncogenes, c-*sis*, *ras*, c-*fos*, c-*jun*, and the role of phosphorylation in the regulation of protein function are illustrated. Since the PDGF receptor is a target for the new Novartis drug, Gleevec™, the pharmacological action of cell-signaling inhibitors can also be stressed. We look forward to launching *Inside Cancer* late in 2003.

Setting up Sister Institutions to the East, West, and North

East In July, we signed a three-year contract with the Ministry of Education (MOE) to use the DNALC model to support expansion of life sciences education in Singapore. The project is part of a national thrust to make biotechnology the "fourth pillar" of Singapore's future economy. With a centrally controlled school system the size of metropolitan Chicago, Singapore potentially provides the first large-scale, integrated deployment of lab-based instruction in genetics and molecular biology. Two years ago, there was essentially no hands-on biotechnology instruction at the precollege level in Singapore—precisely where the United States was in 1988 when we started the DNALC.

In addition to the DNALC project, significant resources are flowing into the school system through both MOE and the Agency for Science, Technology, and Research (A*STAR). Over the past two years,

The DNA Learning Center *West* opened its doors in June, 2002.

virtually every high school has been equipped with basic equipment for DNA analysis—including PCR machines, which have proved the stalling point for many American high schools. Recent government studies have pointed to the need to liberalize some elements of the highly structured school system. Teachers are being encouraged to experiment with new courses and enrichment activities. Thus, all the factors seem right to create in Singapore a superb model for preparing students to live, work, and fruitfully participate in the gene age.

The project got off to a fast start, with DNALC staff conducting three weeks of training in Singapore for middle- and high-school faculty. Twelve Singaporean teachers then participated in three-week "attachments" in the United States, attending DNALC workshops here and in Boston. By year's end, four teaching labs and a bioinformatics lab modeled after the DNALC were under construction at the Singapore Science Center (SSC), which will focus on student enrichment, and the National Institute of Education (NIE), which will focus on teacher training. Complete mirrors of the DNALC WWW sites were also installed at NIE (http://dnalc.nie.edu.sg) and the Singapore Bioinformatics Institute (http://dnalc.bii.a-star.edu.sg).

West With the strong support of CSHL trustee Arthur Spiro, we collaborated with the Research Institute of the North Shore–Long Island Jewish (NS–LIJ) Health System to establish a DNA Learning Center *West* in Lake Success, New York. The new center, which opened in June, includes a genetic/biochemistry lab, prep lab, and office. Lab field trips at *West* include a tour of the adjacent Clinical Core Laboratory. The objective of the new center is to extend DNALC services to schools in Western Nassau County, Brooklyn, Queens, and Manhattan. Toward this end, five weeks of student workshops were conducted during the summer, and field trips during the first half of the academic year brought total attendance to 700 during the first year of operation.

North In October, we commenced collaboration with the Science Center of Eastern Connecticut, in New London, to update their instructional activities with labs and multimedia experiences in molecular genetics. This was part of a reorganization from which emerged the Science Epicenter & DNA Learning Center (SE DNALC). The objective here is to serve Connecticut school systems located directly across Long Island Sound from us. Together with DNALC *West*, SE DNALC potentially will extend our influence in an arch around Long Island Sound, serving much of the major population center of the Northeast. The project is of special interest to Pfizer, Inc., whose central research division is located in nearby Groton.

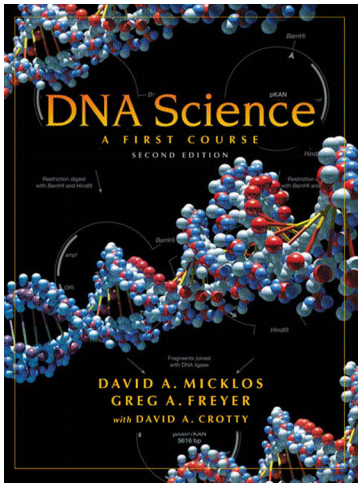
Technology transfer (including the Singapore, NS–LIJ, and Science EpiCenter collaborations; sponsored research by the Carolina Biological Supply Company; and royalties on teaching kits and CDs) contributed about $365,000 in annual revenue, or about 15% of the 2002 operating income. We are exploring additional licensing collaborations with Roberson Museum and Science Center in Binghamton, New York, and the city of Leipzig, Germany.

DNA Science, 2nd Edition

By year's end, the second edition of our popular lab text, *DNA Science*, was in press. The 2nd edition preserves the successful formula of the 1st edition: one part well-tested laboratories and one part insightful, explanatory text. First circulated in mimeographed form in 1988 and formally published in 1990, this book was largely responsible for bringing DNA experiments within reach of advanced high school and beginning college students.

The core laboratory sequence, developed by Dave Micklos and Greg Freyer in the laboratory of CSHL Nobel Laureate Rich Roberts, introduces the basic techniques of DNA restriction, transformation, isolation, and analysis—and then applies these techniques to the construction and analysis of a simple recombinant DNA molecule. We resisted the temptation to tinker very much with the laboratories, since they are the best-tested and most widely used teaching labs available on the basic techniques of gene manipulation. Two new labs focus on gene products: a colorimetric assay for the activity of β-lactamase (the enzyme produced by the ampicillin resistance gene) and expression and purification of green fluorescent protein.

The text portion has been entirely reorganized and updated, increasing from 200 to 300 pages. As before, the narrative takes students behind the scenes of modern research to show them the evolution of concepts and methods. The first three chapters cover essential principles of genetics, and DNA structure and function. The next three chapters introduce small- and large-scale methods for analyzing DNA, culminating in the race to sequence the human genome and new methods for working with hundreds of genes simultaneously. The final two chapters focus on the applications of molecular techniques to understand cancer, human variation, and our emergence as a species. The human genetics chapter also contains the first substantial treatment of American eugenics available in a general biology text.



Although much has changed in biology since the first edition, the ideas and techniques in this book are still the minimum requirements for any degree in DNA manipulation. We hope that *DNA Science* continues to provide a simple roadmap for beginning an exploration of the molecule of life—one that will take on added importance as more and more biology teachers around the world realize the value of giving students the freedom to get their hands dirty with DNA.

HHMI Bioinformatics

The free publication of genome sequences and bioinformatics tools offers students and teachers the unprecedented opportunity to work with important biological data at the same time and with the same tools as researchers. With funding provided by the Howard Hughes Medical Institute (HHMI), we continued to encourage students and teachers to make use of this trove of data. Our HHMI program introduces students and faculty to genomic biology and bioinformatics using a mobile, networked computer laboratory. Central to the program is *VectorNet*, a stand-alone, portable computer laboratory consisting of 12 laptops and a laptop server. The server mirrors the entire DNALC *Gene Almanac* site, including bioinformatics tools and *GenBank* data sets.

The student component of the HHMI project, *New York City Genes*, reached 1662 primarily minority students. Working in collaboration with CUNY's *Gateway Institute for Pre-College Education, VectorNet* was rotated to Erasmus High School (Brooklyn), Science Skills Center High School (Brooklyn), the High School for the Humanities (Manhattan), and John F. Kennedy High School (Bronx). The availability of a set of networked computers in the biology classroom allowed students to move between lab experiments and computer analysis of their own DNA polymorphisms. *VectorNet* saw intensive use in Community School District 29, where students worked on our multimedia on DNA forensics activity, *The Mystery of Anastasia*.

During the year, *VectorNet* was used to train 355 biology educators. Of these teachers, 235 attended short-term workshops at in-services and national conventions; the remaining 122 attended one of six-week-long *Vector Bioinformatics* workshops held at sites across the nation:

- Contra Costa County Office of Education, Pleasant Hill, California
- Foundation for Blood Research, Scarborough, Maine
- National Center for Biotechnology Information, Bethesda, Maryland
- Southwest Foundation for Biomedical Research, San Antonio, Texas
- Stowers Institute for Medical Research, Kansas City, Missouri
- Whitehead Institute for Biomedical Research, Cambridge, Massachusetts

During the workshop, participants make extensive use of computer tools to learn principles of gene analysis, including DNA sequence annotation, gene structure and regulatory elements, gene families and whole-gene analysis, functional genomics and DNA arrays, and gene discovery using SNPs and other markers. Participants also amplify two DNA polymorphisms and use their own data as a starting point to investigate DNA data sets, population genetics, human origins, and disease mechanisms. This illustrates the crossover between DNA experiments done *in vitro* (test tubes) and *in silico* (computers).

At the workshop WWW site, we continued development of lesson plans and user-friendly bioinformatics tools for the analysis of DNA—such as nucleotide counters, a start/stop-codon searcher, and a restriction site finder. The web site currently logs about 1000 visitors per month. DNALC staff also joined CSHL's Meetings and Courses department in developing and teaching a two-day bioinformatics course for research scientists. During 2002, 142 researchers from around the country participated in *The Genome Access Course* (*TGAC*), which was conducted five times at the CSHL Woodbury Cancer Genome Research Sequencing Center.

Leadership Institute in Human and Molecular Genetics

Modeled after the intensive graduate training programs held at CSHL, the Pfizer-funded *Leadership Institute* provides high-level training for a select group of high school faculty. Known also by its nickname, *DNA Boot Camp*, the 2002 program brought together 18 exemplary high school teachers from across the United States, as well as four educators from Singapore. During the intensive three-week workshop, participants performed laboratories from the DNALC's new module in human and plant genomic biology, made extensive use of the computer laboratory as they investigated bioinformatics, and worked on independent projects. They shared lodging and dining facilities with CSHL staff and visiting scientists, and spent the weekends exploring Long Island and Manhattan. This eclectic group of lead teachers represented 16 states, from the urban Northeast, to the rural South, to the Southwest and Northwest.

New NSF Plant Initiative

Plant molecular genetic and genomic research still lag behind medically oriented research on microbes and higher animals. As a result, relatively few lab experiences that expose students to the growing insights into plants offered by genomic biology are available at the lower college level. So we were happy when, in December, the National Science Foundation (NSF) funded our proposal to develop a laboratory- and Internet-based curriculum to bring college students up to the minute with modern plant

Wild type (left) and mutant *clf-2* (right) of the model plant *Arabidopsis thaliana.*

research. This proposal clearly struck a common chord with the six reviewers, all of whom rated it as "excellent." This is the first time in 15 years that any proposal we have submitted has received such a unanimous vote of confidence from NSF reviewers.

The project is based largely on data emanating from plant research at CSHL. A comprehensive set of laboratories will be based on rapid and reproducible PCR chemistry developed under a previous NSF grant. Using the model plant *Arabidopsis* and important food crops, the laboratories illustrate key concepts of gene and genome analysis, including the relationship between phenotype and molecular genotype, genetic modification of plants and detection of transgenes in foods, and linkage and bioinformatic methods for gene mapping. Students will also have the unique opportunity to explore functional genomics by assisting CSHL researcher David Jackson with the cellular analysis of *Arabidopsis* genes of unknown function. An Internet "super site" will support the laboratories with online protocols, custom analysis tools, shared databases, and collaborative bulletin boards.

The project will be kicked off in June 2003 with a focus workshop of faculty advisors drawn from two- and four-year colleges representing six regions of the United States. During the dissemination phase, in 2004–2005, faculty advisors will organize week-long training workshops to reach 144 instructors.

Student Instruction

In 2002, we brought our newly enlarged facility into full operation—including three teaching labs and a computer lab. With an expanded menu of lab field trips, we provided lab experiences for more than 14,000 middle- and high-school students—an increase of 30% over 2001. We also marked an exciting milestone, with 100,000 students having participated in lab experiments at the DNALC since the opening of our first laboratory in 1988. Although our programs are targeted primarily at school groups, we also welcomed 6000 members of the general public, who combine a visit to *The Genes We Share* exhibit with *Long Island Discovery*, Cablevision's multimedia production that chronicles the colorful history of Long Island.

Genetics as a Model for Whole Learning (GMWL), our program of in-school instruction and lab fields trips for 5–7th graders, reached over 17,000 students in 40 school districts and private schools on Long Island. Field trips to the DNALC combine lab work—such as extracting DNA or transforming DNA into bacteria—with a tour of our new museum exhibit, *The Genes We Share*. The multimedia exploration, *Anastasia: Dead or Alive?* continues to be popular for field trips, but faculty are also using the WWW version in their own classrooms.

During the year, we renewed a contract with the New York City Board of Education to provide the *GMWL* program to more than 1800 minority students in Community School District #29 in Queens. We continued our ongoing partnership with CUNY's *Gateway Institute for Pre-College Education*, which provides enrichment to prepare minority high school students for success in higher education. We pro-

vided *gratis* lab field trips for 450 *Gateway* students and minority students from Central Islip High School, Elmont Memorial High School, Theodore Roosevelt High School, Martin Van Buren High School, and Midwood High School.

Founded in 1985, the DNALC's *Curriculum Study* program remains the nation's oldest and largest coordinated effort in the country to bring molecular biology and recombinant DNA technology into the science classroom. Our 38 member districts include both public and private schools in Suffolk, Nassau, Queens, the Bronx, and Manhattan. In 2002, we welcomed three new members to the *Curriculum Study* Program: Kings Park Central School District, Fordham Preparatory School, and North Shore Hebrew Academy High School.

Great Moments in DNA Science, the *Curriculum Study* Honors Student Seminars, attracted 467 area high school students during three evenings in April. The speakers, and their topics of discussion, were:

- Peter Mombaerts, The Rockefeller University: Cloning and Embryonic Stem Cells
- Vivek Mittal, Cold Spring Harbor Laboratory: Exploring Cancer with DNA Microarrays
- Maureen O'Leary, Stony Brook University: The Origins of Whales: Discovering an Evolutionary Transition from Land to Sea Using Molecules and Bones

The summer proved to be our busiest and most productive workshop season to date. We conducted 29 student workshops at the DNALC and DNALC *West*, reaching a total of 676 students—a 34% increase over 2001 attendance. Off-site, we supported *gratis* workshops for 72 minority students at Central Islip High School (Suffolk), Wyandanch High School (Suffolk), Brooklyn Technical High School (Brooklyn), and John F. Kennedy High School (Bronx).

Staff and Interns

The DNALC bid farewell to several staff members in 2002. Maureen Cowan left her position as a middle school educator to pursue a career as a chemistry teacher at St. Mary's School in Manhasset. Our talented multimedia designer Wen-Bin Wu returned to Hong Kong to run his family's import-export business. Hong Zhou departed as manager of our *DNA Sequencing Service*.

The ranks of the instructional group were swelled by the arrival of Erin Maroney, Kimberly Kessler, and Michael O'Brien. Erin has a degree in plant and soil science from the University of Vermont (2001). She teaches and helps administer the middle school program. With a degree in biology from Boston College (2002), Kimberly manages our after-school intern program, in addition to teaching middle and high school students. Michael graduated from SUNY at Albany in May 2002 with a degree in Biochemistry and Molecular Biology. In addition to teaching high school labs, he manages the *DNA Sequencing Service*. Kimberly and Michael are both "alumni," having visited the DNALC as high school students. Kimberly performed labs here as part of SUNY Stony Brook's Women in Science and Engineering. Michael was a student of Fred Gillam at Sachem High School, who was among the first high school faculty to implement the *DNA Science* curriculum.

The *BioMedia* Group continues to thrive, and has nearly doubled in size in response to recent ambitious projects, including *DNA Interactive* and *Inside Cancer*. Thus, we were delighted to welcome three new members to our design staff: Eun-Sook Jeong, Darius Farraye, and Karwai Pun. With Master of Art degrees from Long Island University at C.W. Post and Honglk University in Seoul, Eun-Sook has crossed several continents in her career as an interior designer and multimedia artist. A native of Korea, she began her career at the DNALC as a summer intern while finishing work toward a master's degree. Darius has a strong background in multimedia web design and received a degree in Interactive Design from The Pratt Institute in 2002. Karwai joined us after having received degrees in art history and multimedia design, and working for an Internet design firm in Norway. A native of Long Island, she also visited the DNALC with her Northport High School biology class.

Fund-raising at the DNALC got a boost in 2002 with the addition of Erin Wahlgren as Senior Development Officer. Erin graduated from Simmons College in Boston with a double major in English and

Art History, and went on to hold development positions at the New York Public Library and Old Westbury Gardens. Although Erin reports to the Development Department, she is an integral part of the DNALC team.

Our high school intern program continues to offer students the opportunity to conduct independent research projects under the direction of Scott Bronson and Jennie Aizenman. Michelle Louie and Dan DeRoulet researched techniques for tagging *Arabidopsis* genes with the jellyfish gene encoding green fluorescent protein. Saroja Bangaru spent the summer with CSHL scientist David Jackson and studied the control of morphogenesis in plants, using maize as a model system. Caroline Lau was selected as an Intel finalist (international) for her work on striped bass population genetics. Jared Winoker and Kunal Kudakia researched human diversity using a combination of computer tools and techniques developed at the DNALC.

In addition to preparing reagents used in our teaching labs, interns play a critical role in our free *DNA Sequencing Service*. Lara Abramowitz, Sirish Kondabolu, and Jonathan Mogen (Half Hollow Hills High School), Eric Paniagua (Long Island School of the Gifted), Alex Hogg (Friend's Academy), Michelle Louie (King's Park High School), and senior intern Alina Duval (Hofstra University) worked together to meet the increasing demand for the DNALC's on-site sequencing service. Joining the intern program in 2002 were Pushpa Abraham (Kings Park High School), Lara Abraham (Half Hollow Hills High School), Jennifer Aiello (Kings Park High School), Christina Bezas (Huntington High School), Michael Casimir (Ward Melville High School), Daisy Choi (Cold Spring Harbor High School), Kimberly Izzo (Kings Park High School), David Wagman (Syosset High School), and Phillip Witkin (Syosset High School).

Bringing DNALC *West* online required recruiting and training a new group of high school interns: Robert Weintraub (Walt Whitman High School); Alinea Noronha (Herricks North High School); and Devin Chu (Archbishop Molloy High School).

The *BioMedia* Group was delighted to welcome Felix Hu back for the summer and Christmas breaks. Felix started his first term at Georgia Tech last year. Tracy Mak, a veteran *BioMedia* intern, also started her first college term last year at Cornell. Felix's sister Regina Hu (Northport High School) and Watson School graduate student Elizabeth Thomas continue to work for us during the year. Ariel Gitlin (Cold Spring Harbor High School) and Ryan Chiu (Horace Mann High School) started as new *BioMedia* interns. Ray Zhang (Elwood John Glenn High School) worked with us for the summer. Amelia Dorrer (C.W. Post) joined the team as a college intern. *BioMedia* interns help with a number of different tasks having to do with web site development, such as writing and editing scripts, animations, and web pages; designing new material; beta-testing web sites; and reviewing video clips.

Several art students took short-term positions at the DNALC to work on production of *The Genes We Share* exhibit, including Dana Liebowitz (Bennington College), Matt Mottola (New York Institute of Technology), Kerry Janney (C.W. Post), and Greg Furjanic (C.W. Post). Exhibit interns performed a range of tasks, such as drafting plans, sculpting and painting the human origins "cave," assembling display cases, filling blood bags with theatrical blood, and hand lettering signage.

The following interns left to pursue their scientific interests in college and/or research. We congratulate Marie Mizuno and Jonathan Mogen for their acceptance into the "Partners for the Future" program. Marie is currently working in the lab of Yuri Lazebnik researching apoptosis while Jonathan is working with Yi Zhong investigating neurofibromatosis 1 (*NF1*) and *presenilin* genes. Eric Paniagua (Long Island School for the Gifted) joined the lab of Jerry Yin to research molecular mechanisms involved in long-term memory. In August, we bid farewell to the following interns as they began their freshman year at the following institutions: Yan Liang Huang (Harborfields High School) University of Notre Dame, Caroline Lau (Syosset High School) Princeton University, Janice Lee (Oyster Bay High School) Boston University, Jarrett Linder (Half Hollow Hills High School) Cornell University, and Alex Witkowski (Cold Spring Harbor High School) SUNY Albany. Daniel DeRoulet (Columbia University) and Rebecca Yee (Wellesley College) used their summer breaks to assist with summer workshops and advanced research projects. Additionally, Andrew Diller left the DNALC to pursue a career in the fine arts and Wayne Chiang (Cold Spring Harbor High School) moved back to Taiwan with his family.

Dave Micklos

2002 Grants

Federal Grants	**Term of Grant**	**2002 Funding**
National Institutes of Health ELSI Research Program		
Creation of an *Image Archive on the American Eugenics Movement*	3/98-3/03	$183,660
National Institutes of Health		
Creation of *Inside Cancer*	1/01-12/03	$274,051
Non-Federal Grants		
Howard Hughes Medical Institute		
Precollege Science Education Initiative for Biomedical Research Institutions	9/99-8/03	$149,664
DNA Interactive Education Program	1/02-12/02	$951,932
Josiah Macy, Jr. Foundation		
DNA from the Beginning	10/97-9/02	$215,251
Pfizer Foundation		
Leadership Institute in Human and Molecular Genetics	1/02-12/02	$69,618

The following schools each awarded a grant for **Curriculum Study:**

Bellmore-Merrick Central High School District	$1,100
Bethpage Union Free School District	$1,100
Commack Union Free School District	$1,100
Elwood Union Free School District	$1,100
Fordham Preparatory School	$2,000
Great Neck Union Free School District	$1,100
Green Vale School	$1,100
Harborfields Central School District	$2,200
Island Trees Union Free School District	$1,100
Jericho Union Free School District	$1,100
Kings Park Central School District	$2,000
Lawrence Union Free School District	$2,200
Levittown Union Free School District	$1,100
Locust Valley Central School District	$1,100
Long Beach City School District	$1,100
Massapequa Union Free School District	$2,200
North Shore Central School District	$2,200
North Shore Hebrew Academy High School	$2,000
Oceanside Union Free School District	$1,100
Oyster Bay-East Norwich Central School District	$2,200
Plainedge Union Free School District	$1,100
Plainview-Old Bethpage Central School District	$2,200
Portledge School	$1,100
Port Washington Union Free School District	$1,100
Roslyn Union Free School District	$1,100
Sachem Central School District	$1,100
South Huntington Union Free School District	$1,100

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

Bayshore Union Free School District	$1,000
Bellmore-Merrick Central High School District	$5,300
Brooklyn District #17	$1,400
Buckley Country Day School	$365
Commack Union Free School District	$425
East Meadow Union Free School District	$4,780
East Williston Union Free School District	$1,680
Elmont Union Free School District	$500
Elwood Union Free School District	$3,235
Farmingdale Union Free School District	$980
Garden City Union Free School District	$6,075
Great Neck Union Free School District	$7,225
Greenvale School	$1,180
Half Hollow Hills Central School District	$4,900
Harborfields Central School District	$9,595
Herricks Union Free School District	$1,125
Holy Family Regional School	$250
Jericho Union Free School District	$5,800
Lawrence Union Free School District	$6,480
Locust Valley Central School District	$16,125
Lynbrook Union Free School District	$500
Mamaroneck Central School District	$2,800
Massapequa Union Free School District	$1,650
North Bellmore Union Free School District	$1,000
Northport-East Northport Union Free School District	$6,160
North Shore Hebrew Academy	$700
Old Westbury School of the Holy Child	$2,115
Oyster Bay - East Norwich Central School District	$2,592
Port Washington Union Free School District	$10,275
Progressive School of Long Island	$300
Queens Community School District #29	$33,375
Rockville Centre Union Free School District	$5,210
Saint Aidan School	$250
Saint Anne School	$350
Saint Dominic Elementary School	$3,500
Saint Edward School	$2,025
Saint Savior School	$350
South Huntington Union Free School District	$12,650
Syosset Central School District	$21,075
Three Village Central School District	$750
United Nations School	$500
Whitby School	$250
Yeshiva Darchei Torah	$250

Sites of Major Faculty Workshops 1985–2002

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

ALABAMA	University of Alabama, Tuscaloosa	1987–1990
ALASKA	University of Alaska, Fairbanks	1996
ARIZONA	Tuba City High School	1988
ARKANSAS	Henderson State University, Arkadelphia	1992
CALIFORNIA	**Foothill College, Los Altos Hills**	**1997**
	University of California, Davis	1986
	San Francisco State University	**1991**
	University of California, Northridge	**1993**
	Cañada College, Redwood City	1997
	Pierce College, Los Angeles	**1998**
	California Lutheran University, Thousand Oaks	1999
	Laney College, Oakland	1999
	California State University, Fullerton	**2000**
	Salk Institute for Biological Studies, La Jolla	2001
	Contra Costa County Office of Education, Pleasant Hill	2002
COLORADO	Colorado College, Colorado Springs	1994
	United States Air Force Academy, Colorado Springs	**1995**
	University of Colorado, Denver	1998
CONNECTICUT	Choate Rosemary Hall, Wallingford	1987
DISTRICT OF COLUMBIA	**Howard University**	**1992,1996**
FLORIDA	North Miami Beach Senior High School	1991
	University of Western Florida, Pensacola	1991
	Armwood Senior High School, Tampa	1991
	University of Miami School of Medicine	2000
GEORGIA	Fernbank Science Center, Atlanta	1989
	Morehouse College, Atlanta	**1991,1996**
	Morehouse College, Atlanta	1997
HAWAII	Kamehameha Secondary School, Honolulu	1990
ILLINOIS	Argonne National Laboratory	1986,1987
	University of Chicago	**1992,1997**
INDIANA	Butler University, Indianapolis	1987
IDAHO	University of Idaho, Moscow	1994
IOWA	Drake University, Des Moines	1987
KANSAS	University of Kansas, Lawrence	1995
KENTUCKY	Murray State University	1988
	University of Kentucky, Lexington	1992
	Western Kentucky University, Bowling Green	1992
LOUISIANA	Jefferson Parish Public Schools, Harvey	1990
	John McDonogh High School, New Orleans	1993
MAINE	Bates College, Lewiston	1995
	Foundation for Blood Research, Scarborough	2002
MARYLAND	Annapolis Senior High School	1989
	Frederick Cancer Research Center, Frederick	1995
	McDonogh School, Baltimore	1988
	Montgomery County Public Schools	1990–1992
	St. John's College, Annapolis	*1991*
	University of Maryland, School of Medicine, Baltimore	**1999**
	National Center for Biotechnology Information, Bethesda	2002
MASSACHUSETTS	Beverly High School	1986
	CityLab, Boston University School of Medicine	1997
	Dover-Sherborn High School, Dover	1989
	Randolph High School	1988
	Winsor School, Boston	1987
	Boston University	**1994,1996**
	Whitehead Institute for Biomedical Research, Cambridge	2002
	Biogen, Cambridge	2002
MICHIGAN	Athens High School, Troy	1989
MISSISSIPPI	Mississippi School for Math & Science, Columbus	1990,1991
MISSOURI	Washington University, St. Louis	1989
	Washington University, St. Louis	**1997**
	Stowers Institute for Medical Research, Kansas City	2002
NEW HAMPSHIRE	St. Paul's School, Concord	1986,1987
	New Hampshire Community Technical College, Portsmouth	**1999**
NEVADA	University of Nevada, Reno	1992
NEW YORK	Albany High School	1987

NEW YORK, continued	Bronx High School of Science	1987
	Columbia University, New York	1993
	Cold Spring Harbor High School	1985,1987
	DeWitt Middle School, Ithaca	*1991,1993*
	DNA Learning Center	1988–1995, 2001–2002
	DNA Learning Center	**1990,1992,1995,2000**
	DNA Learning Center	*1990–1992*
	Fostertown School, Newburgh	*1991*
	Huntington High School	1986
	Irvington High School	1986
	Junior High School 263, Brooklyn	*1991*
	Lindenhurst Junior High School	*1991*
	Mt. Sinai School of Medicine, New York	1997
	Orchard Park Junior High School	*1991*
	Plainview-Old Bethpage Middle School	*1991*
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–1990
	Titusville Middle School, Poughkeepsie	*1991,1993*
	Wheatley School, Old Westbury	1985
	US Military Academy, West Point	**1996**
	Stuyvesant High School, New York	1998–1999
	Trudeau Institute, Lake Saranac	2001
NORTH CAROLINA	North Carolina School of Science, Durham	1987
OHIO	Case Western Reserve University, Cleveland	1990
	Cleveland Clinic	1987
	North Westerville High School	1990
OKLAHOMA	School of Science and Mathematics, Oklahoma City	1994
	Oklahoma City Community College	**2000**
	Oklahoma Medical Research Foundation, Oklahoma City	2001
PENNSYLVANIA	Duquesne University, Pittsburgh	1988
	Germantown Academy	1988
SOUTH CAROLINA	Medical University of South Carolina, Charleston	1988
	University of South Carolina, Columbia	1988
TEXAS	J.J. Pearce High School, Richardson	1990
	Langham Creek High School, Houston	1991
	Taft High School, San Antonio	1991
	Trinity University, San Antonio	**1994**
	University of Texas, Austin	**1999**
	Austin Community College-Rio Grande Campus	2000
	Southwest Foundation for Biomedical Research, San Antonio	2002
UTAH	University of Utah, Salt Lake City	1993
	University of Utah, Salt Lake City	**1998,2000**
VERMONT	University of Vermont, Burlington	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
WASHINGTON	**University of Washington, Seattle**	**1993,1998**
	Fred Hutchinson Cancer Research Center, Seattle	1999,2001
WEST VIRGINIA	Bethany College	1989
WISCONSIN	Marquette University, Milwaukee	1986,1987
	University of Wisconsin, Madison	1988,1989
	Madison Area Technical College	**1999**
WYOMING	University of Wyoming, Laramie	1991
AUSTRALIA	Walter and Eliza Hall Institute and University of Melbourne	1996
CANADA	Red River Community College, Winnipeg, Manitoba	1989
ITALY	Porto Conte Research and Training Laboratories, Alghero	1993
	International Institute of Genetics and Biophysics, Naples	1996
PANAMA	**University of Panama, Panama City**	**1994**
PUERTO RICO	University of Puerto Rico, Mayaguez	1992
	University of Puerto Rico, Mayaguez	**1992**
	University of Puerto Rico, Rio Piedras	**1993**
	University of Puerto Rico, Rio Piedras	1994
RUSSIA	Shemyakin Institute of Bioorganic Chemistry, Moscow	1991
SINGAPORE	National Institute of Education	2001–2002
SWEDEN	Kristineberg Marine Research Station, Fiskebackskil	1995

2002 Workshops, Meetings, and Collaborations

January 14–15	Site visit by Lisa Darmo, Elizabeth Paine, and Lawrence Wallace, Carolina Biological Supply Company, Burlington, North Carolina
January 17–19	*DNA Interactive* Advisory Board Meeting, Banbury Center and DNALC, CSHL
January 22	Site visit by Philip Batterhan, International Congress of Genetics, Melbourne, Australia
January 28	*New York City Genes* teacher training, York College, Queens, New York
January 28–31	The O'Reilly Bioinformatics Technology Conference, Tucson, Arizona
January 30	National Institute of Social Sciences Issues Discussion Group, Colony Club, New York, New York
February 1	Inter-School Exchange Reception, DNALC
February 8	Site visit by Richard Riley, Clemson University, Clemson, South Carolina
February 19	Site visit by James Ravanis and Steven Spofford, Rindge School of Technical Arts, Cambridge, Massachusetts
February 19–22	Site visit by Phoon Lee Chaeng, Goh-Goh Poh Gek, Cheong Kim Fatt, and Lee Seng Hai, Singapore Ministry of Education; Anne Dhanaraj, Singapore Science Centre; and Lee Sing Kong, Singapore National Institute of Education
February 25	Site visit by Gail Carmack, UTeach Program, University of Texas-Austin
February 25–27	National Institutes of Health *Science Education Partnership* Award Meeting, Houston, Texas
February 26	Site visit by Regan Huff, McWane Center, Birmingham, Alabama
February 28	Site visit to Biogen, Cambridge, Massachusetts
March 6–8	National Institute of Standards and Technology, *Best Practices* Meeting, Gaithersburg, Maryland
March 7	Site visit Bonnie Kaiser and Robert Schill, The Rockefeller University, New York, New York; and Catherine Rubin, EduChange
March 8	Site visit by Jennifer Chidsey and Paul Flagg, Ross School, East Hampton, New York
March 11	Exhibit development meetings with Mark Holterman, University of Illinois at Chicago; and David Teplica
March 11–13	Howard Hughes Medical Institute Undergraduate Program Review, Chevy Chase, Maryland
March 15–20	*DNA Interactive* editorial meeting, London and Cambridge, England
March 20–24	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Contra Costa County Office of Education, Pleasant Hill, California
March 27–30	National Science Teachers Association Annual Meeting, San Diego, California
April 3	*Your Genes, Your Health* interview, Dominick Sabatino, Nassau University Medical Center, East Meadow, New York
April 4	Site visit by Carson Powers, David Tesseo, Jean Caron, Phil Maniscalo, Martha Grossel, and Richard Hinman, Science Center of Eastern Connecticut, New London
April 9	*Your Genes, Your Health* interview, Anthony Cervo
April 14–16	National Institutes of Health ELSI conference, *American Eugenics and the New Biology: Perspectives and Parallels*, Banbury Center, CSHL
April 15	*Great Moments in DNA Science* Honors Students Seminar, CSHL
April 20–21	Presentation for *Genomic Revolution* exhibit opening, North Carolina Museum of Natural Sciences, Raleigh
April 23	*Great Moments in DNA Science* Honors Students Seminar, CSHL *Your Genes, Your Health* interview, Robert Desnick, Mount Sinai School of Medicine, New York, New York
April 24	National Institute of Social Sciences Board Meeting, Harvard Club, New York, New York
April 25	Presentation for Sayville High School Career Café Day
April 27	Presentation for Arbor Day Festival, Planting Fields Arboretum, Oyster Bay, New York
April 29	*Great Moments in DNA Science* Honors Students Seminar, CSHL
May 7–9	*DNA Interactive* filming, San Francisco, California
May 10	Site visit by Huanming Yang, Beijing Genomics Institute, China
May 13–15	National Human Genome Research Institute ELSI Project, *Eugenics Image Archive*, Editorial Advisory Panel Meeting, Banbury Center, CSHL
May 17	Site visit by Eugene Mitacek and Suzanne Ettinger, New York Institute of Technology, Old Westbury
May 21	*DNA Interactive* editorial meeting, DNALC *Your Genes, Your Health* interview, Edwin Kolodny, New York University School of Medicine, New York
May 22	Site visit by Don Colbert, SUNY Binghamton
May 28–June 1	Teacher training workshop, National Institute of Education, Singapore

May 29–30	Site visit by Janna Greenhalth and Pat Quinn, Science Center of Eastern Connecticut, New London
June 3–14	Teacher training workshops, National Institute of Education, Singapore
June 11	*Your Genes, Your Health* interview, Susan Fishbein, Late Onset Tay-Sachs Foundation, Glenside, Pennsylvania
June 13	Site visit by Kevin Seeley, Pall Corporation, Port Washington, New York
June 17–21	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Southwest Foundation for Biomedical Research, San Antonio, Texas
June 19	Josiah Macy, Jr., Foundation Meeting, DNALC
June 20	*Your Genes, Your Health* interview, Judith Willner and Randi Zinberg, Mount Sinai School of Medicine, New York, New York
June 24	DNA Learning Center *West* opening and reception, Lake Success, New York
June 24–28	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Stowers Institute for Medical Research, Kansas City, Missouri
June 25	Site visit by Frederick Seitz and Florence Arwade, Lounsbery Foundation
June 27–July 3	*Fun With DNA* Workshop, DNALC *Fun With DNA* Workshop, DNALC *West* *World of Enzymes* Workshop, DNALC *DNA Science* Workshop, DNALC
July 8–12	*Fun With DNA* Workshop, DNALC *Fun With DNA* Workshop, DNALC *West* *World of Enzymes* Workshop, DNALC *DNA Science* Minority Workshop, Central Islip High School, New York
July 8–26	Pfizer *Leadership Institute in Human and Molecular Genetics*, DNALC
July 9	*Your Genes, Your Health* interview, the McHale family
July 12	Site visit by Woodrow Wilson Biology Institute participants
July 15	Site visit by *Gateway Institute for Pre-College Education* administrators and teachers
July 15–19	*Green Genes* Workshop, DNALC *DNA Science* Workshop, DNALC *DNA Science* Minority Workshop, Wyandanch High School, New York
July 16	*Your Genes, Your Health* interviews, Michael Shelanski, Columbia University, New York, New York; and Thomas Winiewski, New York University School of Medicine, New York
July 19	Site visit by Mary Miller and Rob Semper, Exploratorium Origins Project, San Francisco, California
July 20–23	*DNA Interactive* editorial meeting, DNALC
July 22–26	*Fun With DNA* Workshop, DNALC *DNA Science* Minority Workshop, John F. Kennedy High School, Bronx, New York *Genomic Biology & PCR* Workshop, DNALC
July 26	Site visit by Matt Ridley, author and chairman of the International Centre for Life, Newcastle upon Tyne, United Kingdom
July 29–August 2	*World of Enzymes* Workshop, DNALC *Green Genes* Workshop, DNALC *Genetic Horizons* Workshop, DNALC *DNA Science* Workshop, DNALC *West* *DNA Science* Minority Workshop, Brooklyn Technical High School, New York
August 5–9	*Fun With DNA* Workshop, DNALC *Fun With DNA* Workshop, DNALC *West* *World of Enzymes* Workshop, DNALC *Genomic Biology & PCR* Workshop, DNALC Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, National Center for Biotechnology Information, Bethesda, Maryland
August 12	Site visit by Lawrence Scherr, North Shore–Long Island Jewish Health System
August 12–16	*Fun With DNA* Workshop, DNALC *Green Genes* Workshop, DNALC *DNA Science* Workshop, DNALC Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Whitehead Institute for Biomedical Research, Cambridge, Massachusetts
August 15	*Your Genes, Your Health* interview, Julie Zale
August 19–23	*Fun With DNA* Workshop, DNALC *World of Enzymes* Workshop, DNALC *DNA Science* Workshop, DNALC *DNA Science* Workshop, Cambridge, Massachusetts

August 19–23, cont.	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Foundation for Blood Research, Scarborough, Maine
August 26–30	*Fun With DNA* Workshop, DNALC
	World of Enzymes Workshop, DNALC *West*
	DNA Science Workshop, DNALC
September 6–9	*DNA Interactive* editorial meeting, DNALC
September 18	*The Genes We Share* exhibit opening
	Site visit by Lisa Darmo, Charles Matthews, George Ross, and Lawrence Wallace, Carolina Biological Supply Company, Burlington, North Carolina
September 25	Site visit by Prince Andrew, Duke of York
September 26–29	*Museums, Media and the Public Understanding of Research* International Conference, Science Museum of Minnesota, St. Paul
September 27	Presentation for Science Center of Eastern Connecticut, New London
September 27–30	Multimedia Educational Resource for Learning and Online Teaching (MERLOT) International Conference, Atlanta, Georgia
October 3	Site visit by Tim Herman and Michael Patrick, Center for BioMolecular Modeling, Milwaukee School of Engineering, Wisconsin
October 6–8	*DNA Interactive* Advisory Panel Meeting, Banbury Center, CSHL
October 7	Site visit by Barbara Delatiner, New York Times
October 9	Site visit to the Carolina Biological Supply Company, Burlington, North Carolina
October 15	National Institute of Social Sciences Board Meeting, New York, New York
October 19–25	Planning and web site development meeting, National Institute of Education, Singapore
October 20	*Your Genes, Your Health* interview, Melissa Goldman
October 25	Site visit by Judith Kirk, Westmead Hospital, Sydney, Australia; and Joe Sambrook, Peter MacCallum Cancer Institute, Melbourne, Australia
October 30–Nov. 2	National Association of Biology Teachers Annual Convention, Cincinnati, Ohio
November 5	*DNA Interactive* filming, Charlottesville, North Carolina
November 7–8	Site visit by Connie Barnes, Elizabeth Button, Diane Carpenter-Crews, Jim Moody, and Mary Sokolowski, SUNY Binghamton
November 13	Site visit by Kathleen Belton and Drew Bogner, Molloy College, Rockville Center, New York
November 14	Site visit by Colin Goddard, OSI Pharmaceuticals, and William Hurt, actor
November 18	Site visit by Daniela Gieseler, German public television
November 22	Site visit by Mary Miller, Exploratorium Origins Project, San Francisco, California
November 25	Site visit by Russ Hodge, European Molecular Biology Laboratory, Heidelberg, Germany
December 2–6	*DNA Interactive* editorial meeting, London, England
	Site visits to Max Planck Institute, Berlin and Leipzig, Germany
December 19	Site visit by Julie Clayton, *Nature* Magazine

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