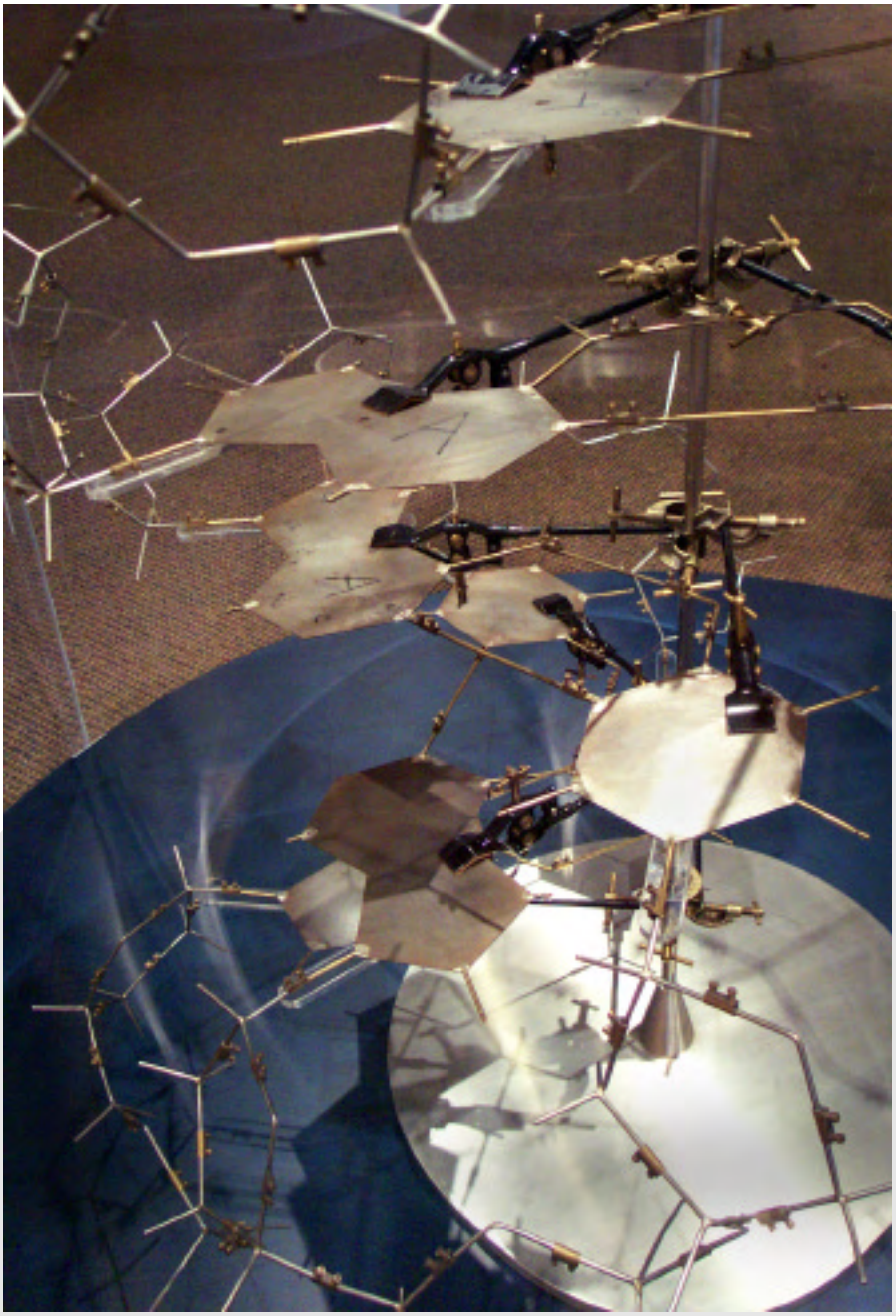


Dolan
DNA Learning Center

2001
Annual Report

DOLAN DNA LEARNING CENTER

Searching for Meaning in the Human Genome

Albert Einstein spent a great portion of his life pondering the forces that govern the universe. His quantum theory sketched out the grand rules by which elementary particles move and interact to construct all matter. In response to the perception that quantum mechanics had reduced life to a set of mathematical probabilities, Einstein famously said, "I cannot believe that God would choose to play dice with the universe." In a similar way, the publication of the human genome sequence, in February 2001, gives us cause to ponder the forces that have shaped our own genetic inheritance and wonder if anyone is playing dice with our genes.

As the race to sequence the human genome heated up, the Cold Spring Harbor Laboratory Meetings Office came up with its own game of chance to divert the attention of visiting gene experts. Called Genesweep, it is a competition to guess the actual number of human genes. Up to within several weeks of the initial publications of the genome sequence, most bets hovered around 100,000 genes, with some going as high as 150,000.

The announcement that two independent sequencing efforts had arrived at a number of approximately 30,000 genes therefore came as a surprise even to experts. This raised an obvious question: How can humans get along with only about twice as many genes as a fruitfly (with 13,000 genes) or a microscopic roundworm (with 19,099 genes)? At least part of the answer lies in the range of informed bets in the Genesweep contest. Bets on larger numbers were in part based on experiments which sample genes that are expressed (active) in different kinds of cells. These methods, and the higher estimates they produced, were favored by the so-called "gene mining" companies—who obviously would like more genes to sell to their clients.

There is good reason for this seeming overestimate. Prior to protein synthesis, the DNA code is transcribed into a complementary RNA code. Through a process called RNA splicing, discovered independently at Cold Spring Harbor Laboratory and the Massachusetts Institute of Technology, the RNA code is cut and spliced to produce different kinds of directions. Thus, although most genes are represented only once in the human genome, a single gene can be alternatively spliced to produce several different proteins. In this way, the genomes of higher organisms can get a lot of proteins out of relatively few genes.

One would have thought that the two independent sequencing projects would have produced enough information to identify every single human gene. However, several recent assessments suggest that both genome projects may have missed as many genes as they found. In fact, it is very difficult to compare or move between the data sets produced by the two projects. Each used different experimental methods and different computer software to search out genes among the raw data. Many genes

are missing from gaps in sequence, where adjacent chromosome pieces have yet to be linked together. Regions containing large amounts of repetitive DNA, especially around the centromeres, will likely never be completely sequenced and assembled—although few genes are likely to be missed there. Thus, a year after what seemed to the general public the definitive effort to sequence the human genome, we still can only guess at the number of genes that make us human. The Genesweep prize has yet to be awarded.

Rightly, the general public and most scientists focus on the genes revealed by the Human Genome Project. Of course, naming and knowing all of our genes will be a great step forward in understanding how our cells work—and exactly what goes wrong in various diseases. Making human life healthier and, presumably, happier are the practical outcomes of the Human Genome Project. However, just as meaning sometimes lies between the lines of prose or verse, some of the meaning of our genome lies between the genes. Indeed, most of the human genome is not the stuff of genes.

The road to sequencing the human genome began in the 1950s and 1960s. During this period, the discovery of the structure of DNA and the cracking of the genetic code showed the rules that allow living matter to be faithfully reassembled in each generation. Although reducing inheritance to a set of chemical probabilities may have unveiled the mystery of procreation, it did not rob life of meaning. For James Watson, Cold Spring Harbor President and co-discoverer of the DNA structure, it was enough that DNA is "a beautiful molecule." Unfortunately,it takes a fair appreciation of chemistry to understand what Jim Watson means by this. Whereas the DNA structure is more than most people can fathom, the genetic code—the directions for making proteins—can be followed by any fifth grader. Therefore, the cracking of the genetic code was comforting, because, at the very least, it makes good sense.

At the same time, other scientists were turning up evidence that protein-coding regions make up only a fraction of the genomes of higher organisms, including humans. Much of this non-gene DNA is found around the centromere, a knob-like swelling in each chromosome. Here, short DNA sequences are repeated tens to thousands of times, creating a vast DNA desert virtually devoid of genes. It is thought that these short DNA repeats arise when the enzyme involved in copying DNA "stutters," losing its place among a string of repeats and adding an extra unit from time to time. Thus, the repeated regions increase in size over the long course of evolution.

Longer DNA repeats are found outside the centromeres. Ranging from several hundred to several thousand DNA units in length, these repeats are not due to duplication errors. Rather, they are transposable elements—so-called jumping genes—that have copied themselves and moved from chromosome to chromosome. Although transposable elements were first discovered in corn, by Cold Spring Harbor Laboratory scientist Barbara McClintock, they have since been identified in every organism studied—including humans.

In the 1970s, a third type of non-gene DNA, termed an intron, was discovered. Up until that time, most of what was known about gene structure had come from studying bacteria in which each gene generally is a continuous stretch of DNA code, beginning with a start codon and ending with a stop codon. The genes of higher organisms (eukaryotes) turned out to be more complex. In these genes, the genetic code is interrupted by numerous introns, giving rise to "split genes." The average human gene has tens of introns, and the intron sequences are almost always longer than the coding sequences. Prior to protein synthesis, the phenomenon of RNA splicing removes the introns to produce a continuous genetic code.

By the start of the Human Genome Project, the going estimate was that these three types of noncoding DNA weighed in at 95% of the human genetic endowment! In comparison, the entire genetic code of all the genes needed for human life was thought to constitute only about 5% of our total complement of DNA. The draft sequence showed that this estimate was overgenerous by a factor of three. It now appears that as little as 1.5% of the human genome actually carries genetic code for making proteins.

Why so little gene information and why so much "junk?" What kind of way is this to run a genome? At least some fraction of noncoding DNA is far from junk.Noncoding regions between genes contain specific sequences—called promoters and enhancers—that regulate when, where, and how much of a protein is produced. This coordinated activity of genes is especially important during embryonic growth and development. Noncoding regions within genes—introns—contain information that

directs RNA splicing, which allows a diversity of proteins to be produced from a single gene. Indeed, gene regulation and splicing are considered the means through which an essentially identical set of mammalian genes is elaborated into a human, a mouse, or a monkey. Thus, it is not the genes that set humans apart, it is what we do with them.

The noncoding DNA that surrounds promoters, enhancers, and splice signals can be explained as the necessary evolutionary "grist" from which these gene regulators emerged. Short repeated units can be dismissed as mere mistakes in the complex machinery needed for replicating DNA. From a metaphysical standpoint, the transposable elements are more difficult to explain. Two transposable elements, called L1 and *Alu*, are the most frequent gene-sized sequences in the human genome. About 1 million copies of *Alu* and 500,000 copies of L1 compose about 27% of human DNA by weight. Each of these hundreds of thousands of copies arose from an individual "jump" at some point in human evolution. L1 transposons came into the genome about 150 million years ago, so we share these sequences with many vertebrates, including fish and mice. *Alu* is only about 65 million years old—young enough that its jumping is confined to primates, the "monkey" branch of the tree of life. Several thousand *Alu* elements are found only in humans, so they have made the jump in the past 6 million years—after humans diverged from a common ancestor with chimps. L1 carries a gene for the enzyme reverse transcriptase (RT), which converts L1 RNA into a mobile DNA copy. This same enzyme enables retroviruses, such as human immunodeficiency virus (HIV), to insert into positions on the human chromosome from which they cause infection. Current thinking holds that the retroviruses borrowed the RT gene from transposons in the host genome.

Interestingly, the L1 RT enzyme has an additional function analogous to restriction enzymes, the "scissors" that allow biologists to precisely manipulate DNA. L1 makes staggered nicks on each side of the DNA molecule, thus providing a site into which a reverse-transcribed DNA copy can integrate into a new chromosome position.L1 appears to search through DNA and make its first cut in a region containing roughly the same string of DNA letters, termed a consensus sequence. But the second nick is unpredictable. Thus, the jumping about that is mediated by L1 RT lies somewhere between predictability and randomness.

Regardless, with no functional genes at all, *Alu* is thought to rely on RT enzyme produced by L1. This makes *Alu* a parasite of L1 in a molecular symbiosis that puts a point on the axiom:

Great fleas have little fleas
Upon their back to bite 'em
And little fleas have lesser fleas
And so ad infinitum.

Biologists struggle to find the meaning of transposons that take so much space in the human genome. Some believe transposons have been successful because they have enabled the genomes they inhabited to compete more successfully on the battleground of evolution. *Alu* jumping peaked 40 million years ago, reaching a rate of perhaps one new jump in each newborn primate. This period roughly coincided with the evolutionary "radiation" that led to the development of forerunners of modern branches of the primate family. *Alu* accumulates in gene-rich regions, and its jumping may be activated under stressful conditions. These facts have led some to speculate that *Alu* transposition has had a positive role in primate evolution, creating gene variations that provided a selective advantage for evolving primates as they adapted to changes in the earth's environment. Other biologists believe that the success of *Alu* and other transposons rests entirely in their own reproductive ability. *Alu*, which makes no protein, may exist solely for its own replication. This fits Richard Dawkins' moniker of "selfish DNA." If one continued on this line of thought, one might craft a definition of life from the viewpoint of DNA:

Life is the perpetuation and amplification of a DNA sequence through time.

According to this view, *Alu* is a supremely successful life form, with a million copies of itself perpetuated in each of the billions of humans and primates alive today.

Of course, most people would not like to entertain the possibility that our genomes are merely

vessels for the reproduction of some selfish and fidgety DNA. Those so inclined might find some cheer knowing that (HOORAY!) some transposons have gone extinct like the dinosaurs. The *Alu*/L1 symbiosis replaced an earlier and virtually identical symbiosis between a sequence called Mer and L2. Although they have not jumped for at least 100 million years, Mer and L2 "fossils" still litter about 5% of the human genome.

All told, various types of transposons make up more than half of our genetic endowment. If possession is nine-tenths of the law, one might ask "Who's in charge of this genome, anyway?" The truth is, we will probably never know for certain whether transposons are part of the plan or just little fleas playing dice with our DNA.

The Genes We Share

By year's end, we were well into production of our own tribute to the human genome project—a new exhibit entitled *The Genes We Share*. The exhibit takes a global look at the incredible genetic similarity of all human beings, as well as the differences that make each person unique. The 2000-square-foot exhibit will include an array of historical items, audiovisual installations, and interactive exhibits. To make way for the new work, we dismantled the long-standing exhibition, *Story of a Gene*, which focused on the biology, medical applications, and social issues of human growth hormone. It nearly broke our hearts to paint over the *Cellarium*, a room-size depiction of the interior of a human cell.

The Genes We Share celebrates the 50th anniversary of the discovery of the DNA structure, which set the stage for the recent efforts to determine the entire DNA sequence of the human genome. As visitors explore the exhibition, they will be 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.

Visitors will be greeted in the front hall with photomurals of crowded "peoplescapes," illustrating the similarities and differences between the people of the world. The main hall (the former *Cellarium*) shifts focus to the individual. An interactive area will allow visitors to observe and make records of their own physical features and to compare these with the features of other individuals. Sharpening focus even closer, microscopic footage and high-resolution animations will highlight body structures and biological processes that we all share. The endpoint of this area will explore DNA variations in our genomes that make each of us unique. DNA and personality profiles of identical twins, Matt and Danny, will help visitors explore the relationship between nature (DNA) and nurture (environment).

Other installations in the central hall will return to the level of human populations and how genetic differences have evolved between them. An interactive map of the world will depict the migration paths of our earliest ancestors and illustrate some of the environmental factors that influenced human evolution. An interactive table, in the shape of

Designers from the London Science Museum install the floor-to-ceiling replica of the original DNA model built by Watson and Crick.

a cellular component called a mitochondrion, will allow visitors to explore the use of DNA to study human evolution and trace our ancestry. Mini-displays highlight unusual DNA "memorabilia"—including the hair of Anna Anderson-Manahan (who claimed to be the Russian Duchess, Anastasia) and the mitochondrial DNA sequence of the Nobel laureate, James D. Watson.

The smallest exhibition space, located beneath the projection room of the Multitorium,will explore the anatomical, genetic, and behavioral changes that evolved to set humans apart from other primates. Skeletons of a chimpanzee, a modern human, and a Neanderthal (the first adult reconstruction ever displayed) will be set within a cave environment. Recreations of prehistoric paintings, as well as Neanderthal and Cro-Magnon burials, will encourage visitors to think about the earliest evidence of human self-awareness. By comparing mitochondrial DNA sequences, visitors will see evidence of genetic changes that accumulated through evolutionary time, since humans shared common ancestors with chimps and Neanderthals.

The interpretation of the human DNA sequence will be introduced by an interactive exhibit,"Stories in Our Genes," in which Matt Ridley presents a guided tour through human chromosomes, based on his popular book, *Genome*.This leads into elements dealing directly with DNA structure and sequencing. An eight-foot-tall reconstruction of the original metal DNA model made by Watson and Crick in 1953 represents the beginning of the quest to understand ourselves. A working DNA sequencer, operating daily to sequence DNA submitted by student classes from around the United States, will illustrate the ubiquity of DNA sequencing technology. Finally, exhibits on DNA "chips" and gene therapy will encourage the viewer to ponder how DNA will affect their future lives and health.

We Become the Dolan DNA Learning Center

On June 8, 2001, we rededicated a facility doubled in size by completion of the *Biomedia* Addition. The ceremony honored the generosity of Charles and Helen Dolan, from whom our institution now takes its name. The Dolan Family Foundation's lead gift toward the $5 million expansion was the culmination of years of support, stretching back to when Helen was a member of the original trustee committee that guided the founding of the DNALC. Charles is a quiet pioneer of the cable television industry, and his company, Cablevision, was the major donor to an earlier 1993 renovation of the DNALC. This venture created our 104-seat auditorium as a venue for *Long Island Discovery*, a multimedia presentation that has been seen by more than 76,000 people visiting the DNALC.

The keynote address was given by Dr. Peter Bruns, Vice President of Grants and Special Programs of the Howard Hughes Medical Institute, which has supported our educational programs for the past seven years. The event also marked the unveiling of a large-scale portrait of Charles and Helen in the formal entrance to the *Biomedia* Addition. The impressionist painting was created by Lewis Miller, an Australian artist whose works at CSHL include a monumental portrait of President James Watson and character sketches of noted scientific visitors. Mr. Miller won the 1998 Archibald Prize, Australia's most prestigious award for portraiture.

The dedication also marked the end of a difficult renovation period, during which the multimedia group sought temporary offices on the main lab campus and the instructional group was crammed into makeshift offices in a former exhibit gallery. United again in our new facility, our educators and multimedia designers can once again collaborate in the manner that has enabled us to create novel instructional materials.

Our new facility, designed by the noted architectural firm Centerbrook, is a joy to inhabit. The entire upper level is given over to multimedia production. Enclosed offices along the length of the building provide quiet spaces for writing, and two open bays and a conference area provide open spaces for collaborative work. The area is home to an eclectic staff with varied backgrounds in research biology, science communication, computer programming, exhibition development, and graphic design.

New and redeveloped spaces on the lower level accommodate our programs for student enrichment and teacher training. Three teaching laboratories are organized around "island" benches of our own

With all major renovation complete, the DNALC was rededicated on June 11, 2001. Clockwise, from top left: The new west entry to the *BioMedia* Addition; upgraded teaching laboratory; garden border in front of the DNALC depicting the DNA helix; terrace and shade garden adjacent to the new lunchroom; and the Lewis Miller portrait of Charles and Helen Dolan, hanging inside the west entrance.

design, which encourage cooperative learning. The laboratories incorporate the latest multimedia projection technology and stereo sound, allowing instructors to integrate digitized lab results with an array of education resources—including live WWW content, molecular animations, videotapes, and DVDs. An adjacent prep lab, complete with DNA sequencer and several types of centrifuges, supports the most advanced experiments by staff and student interns.

The striking, octagonal computer laboratory is the symbolic heart of the building, emphasizing the increasing use of computers to "mine" the genetic information encoded in DNA molecules. Like today's genome scientists, DNALC students now have the opportunity to move effortlessly between *in vitro* ("in glass," or test tube) manipulations of DNA biochemistry to *in silico* (computer) manipulations of the genetic information stored in DNA. For example, in the biochemistry lab, students can isolate their own DNA, amplify a variable region by PCR, and analyze the results by gel electrophoresis. Then, in the computer laboratory, student DNA types are entered into a database and the class "population" is compared to world population using statistical measures.

Instructional staff share a communal office, and a reception/business office sets a professional tone to our interaction with visiting teachers and administrators. In addition, updated restrooms have replaced the antiquated (and tiny) facilities installed in 1925 for elementary children who were the building's first clientele. The original girls' lavatory found new use as a corridor to provide common access to the three teaching laboratories. A new lunchroom allows students to have a relaxed meal looking out on our shade garden, rather than huddling in the hallway or on a school bus.

Instructional Programs

Despite the mayhem of operating a building under construction—including a three-month abandonment of two teaching laboratories during renovation of the original building—a total of 20,868 teachers and students, representing 102 school systems, took part in DNALC laboratory activities during 2001. Amazingly, this number very nearly matches the level of calendar year 2000, when we hosted 21,750 workshop and lab participants. With three functional laboratories up and running by late spring, we increased summer programs by 22%; 557 students participated in workshops at the DNALC as well as at John F. Kennedy High School (Bronx), Brooklyn Technical High School (Brooklyn), and Central Islip High School (Central Islip).

Our *DNA Sequencing Service* doubled in size, processing over 2,000 samples submitted by 64 high schools, 38 universities, and 5 community colleges. Developed several years ago with funding from the National Science Foundation, this service offers students the unique opportunity to use their own DNA to learn elements of modern genomic biology. The exponential growth of this program has been made possible by the gift of a 377 DNA sequencer and ongoing donations of sequencing reagents and instrument service by Applied Biosystems, which allows the DNALC to increase the size of our program while continuing to provide the service for free. Technical support for the *Sequencing Service* is provided by several research staff at the main CSHL campus: Joan Alexander, Spencer Teplin, Ray Preston, and Patrick Smith.

Using a kit developed by the DNALC and distributed by Carolina Biological Supply Company, students isolate DNA from their own hair roots or cheek cells. Their DNA is mixed with freeze-dried PCR reagents to amplify (clone) a highly variable region of the mitochondrial genome. The amplified samples are then mailed to the DNALC, where high school interns perform the final DNA sequencing reactions. The student DNA sequences are then databased in an educational workspace at our WWW site, from which students can launch a number of analyses, including BLAST searches and CLUSTAL sequence alignments. A companion WWW site, *Genetic Origins*, contains everything needed to reproduce the experiment and use the results to explore unanswered questions in human evolution.

For the past several years, middle-school field trips had combined lab work with interpretive use of the *Story of a Gene* exhibit. Thus, dismantling the exhibit required us to rethink how we could continue to provide a rich experience for middle-school students while we develop the new exhibit, *The Genes We Share*. We turned this quandary into an opportunity to quickly integrate the computer laboratory into the life of the DNALC.

Working directly with multimedia designer Chun-hua Yang, the middle-school staff developed a guided multimedia module for middle-school visitors. The result was an interactive mystery based on the true story of Anastasia Romanov. During a typical session, a DNALC instructor uses video clips from the NOVA video, *Anastasia: Dead or Alive*, to introduce the Romanov family and circumstances of their murder in 1918.

Middle-school students participate in the Anastasia computer experience led by educator Maureen Cowan.

Students then work collaboratively at their computer stations, using forensic methods to determine the ages and sexes of skeletal remains from a common grave in Siberia. Comparing DNA from the skeletons to living descendants of the Russian royal family confirms the identity of the five Romanovs, but leaves open the fate of the youngest daughter, Anastasia. Following this story, students compare the lives and physical features of Anna Anderson, a woman who many people, including some surviving Russian royalty, believed was Anastasia. A comparison of Anna Anderson's DNA with that from the bones in the Siberian grave recreates scientific experiments conducted in the 1990s and provides the final word on the mystery of Anastasia. Teacher and student reaction to the *Anastasia* module has been almost overwhelming. We believe the module is one of the very best examples of effective use of multimedia in science education. By year's end we had begun development of a WWW version to make this stunning work available worldwide.

In the spring, we continued our honors seminar series for local students, *Great Moments in DNA Science*. The program attracted 476 secondary science students to a range of topics in modern biology:

- Dr. Gregory Hannon, Cold Spring Harbor Laboratory: "The Role of Cell Proliferation Control in Cancer"
- Robert Baumann, Suffolk County Crime Laboratory: "The Use of DNA in Criminal Investigations"
- Dr. Howard Rosenbaum, American Museum of Natural History: "Working With Whales: DNA as a Useful Tool for Conserving the World's Largest Creatures"

Expanding the DNALC Model to the East and West

Director Dave Micklos meets with students in Singapore.

The year provided us with new opportunities to disseminate our unique way of working. Following up on a visit in October 2000 from the Minister of Education, RAdm Teo Chee Hean, of the Republic of Singapore, we worked with ministry officials to explore the possibility of setting up a sister institution in the island republic noted for student science achievement. During a week-long visit in February, DNALC director David Micklos was given an extensive tour of all levels of the science education and research system, including elementary and secondary schools, junior and technical colleges, and the national university and research institutes. In May, Dave and Scott Bronson returned to Singapore to instruct a *DNA Science* Workshop for high school and junior college faculty, and four Singaporean educators visited the DNALC in July to attend the Pfizer *Leadership Institute*.

In the following months, continuing discussions led to the proposal to establish two institutions in Singapore based closely on the DNALC model. One, at the Singapore Science Centre, will focus on student enrichment and public outreach. The other, at the National Institute of Education, will focus on teacher training. We anticipate a high-level visit from the Ministry in 2002 and a subsequent multi-year agreement for the substantial transfer of intellectual property to the Singapore centers—including teacher training, technical assistance, WWW site mirroring, and joint curriculum development. With central control of a school system about the size of Chicago, we regard this as a unique opportunity to experiment with the rapid and large-scale deployment of instructional methods we have developed over the past 15 years.

Closer to home, a different opportunity presented itself when CSHL Trustee Arthur Spiro proposed to develop a "DNALC West" in collaboration with the Research Institute of North Shore-Long Island Jewish (NS-LIJ) Health System. In this case, it was agreed that the DNALC will operate a teaching lab hosted at NS-LIJ, mirroring lab field trips and summer workshops conducted at the DNALC. By year's end, plans were in hand for a teaching laboratory and student lunchroom to be located in space adjacent to the system's diagnostic laboratories, just off the Northern State Parkway in Lake Success. The NS-LIJ facility will allow us to better serve school districts in western Nassau County, Brooklyn, Queens, and Manhattan.

Howard Hughes *VectorNet* Programs

With funding from the Howard Hughes Medical Institute (HHMI), we continued our longstanding effort to introduce students and faculty to the use of modern networked computing in genomic biology. Central to this effort is *VectorNet*, a stand-alone, portable computer laboratory, consisting of 12 user laptops and a laptop server. The program is based on our earlier work with *Vector* mobile DNA laboratories—specially designed Ford vans and reagent kits we introduced in the mid-1980s to deliver teacher training in molecular genetics to sites around the country. Vans and DNA footlockers are now standard methods for resource sharing between schools in many regions of the country. In a similar way, *VectorNet* was designed to prove the feasibility of "backpacking" a bioinformatics computer laboratory essentially anywhere.

The student component, *New York City Genes* is a collaborative project with the *Gateway to Higher Education Program*, a major science education initiative by Mt. Sinai Medical School and NYC public schools. In 2001, we trained 55 high school teachers from New York City to use the *VectorNet* Laboratory to access the DNALC's rich Internet content, data analysis tools, and online bioinformatics facilities. In the spring, the *VectorNet* system was rotated to Brooklyn Technical High School (Brooklyn), the High School for the Humanities (Manhattan), and Stevenson High School (Bronx) where it was used by some 250 primarily minority students in grades 9–11. The availability of a set of networked computers in the biology classroom allowed students to move between lab experiments and computer analyses of their own DNA polymorphisms.

Bioinformatics is a relatively young discipline that attempts to analyze the information content of DNA. Since it merges biology and information technology, the field offers an interesting means to involve computer-literate students in science. Most bioinformatics tools and data sets are freely available on the Internet. Students and teachers have the unprecedented opportunity to use the same tools that biologists do to explore the human genome.

The *Vector Bioinformatics* Workshop aims to enable teaching faculty to take advantage of the treasure trove of DNA data flowing from the Human Genome Project, while improving basic computer skills. During its first summer, 78 high school and college faculty participated in workshops held at four independent research institutions. We relished the chance to visit these wonderful institutions and renew friendships with local organizers who were essential to our summer success:

Susan Cooper, Trudeau Institute, Saranac Lake, New York
Nancy Hutchison, Fred Hutchinson Cancer Research Center, Seattle, Washington
Ellen Potter, Salk Institute, La Jolla, California
Philip Silverman, Oklahoma Medical Research Foundation, Oklahoma City

The week-long workshop guides participants in logical steps from DNA isolation through sequence basics to *in silico* gene discovery. The workshops begin with basic methods for analyzing patterns in DNA sequences and progress to online algorithms that identify gene features, including open reading frames and intron/exon boundaries. Participants then use genome browsers to find genes in online databases, identify their chromosome locations, identify homologs in other organisms, and explore their involvement in normal and disease processes. Conceptually, the week culminates in the investigation of pharmacogenetics and the research efforts to identify single nucleotide polymorphisms (SNPs) that predict disease susceptibility and drug response.

The computer work is punctuated by biochemistry labs that use the teacher's own DNA as a starting point for online analysis, using the DNALC's custom *BioServers*. Simple DNA types at the PV92 locus on chromosome 16—developed *via* PCR and gel electrophoresis—are the basis for studies of human population genetics and tests of competing theories of human origins. Making use of the DNALC's *Sequencing Service* (described above), sequencing the control region reveals SNPs in each participant's own DNA and provides a foundation for sequence comparisons and database searches.

Pfizer *Leadership Institute*

Originally supported by the National Science Foundation during summers from 1993 through 1995, the *Leadership Institute in Human and Molecular Genetics* returned in 2001 with Pfizer Foundation funding. Affectionately known as "DNA Boot Camp," this *Institute* is to high school biology teachers what the CSHL postgraduate research courses are to scientists—an intense immersion into high-level experimentation and thinking. During their three-week stay in July, participants are housed on the main campus of CSHL, where they can interact with CSHL staff and visiting scientists at meals and seminars.

The 20 faculty participants in 2001 represented 14 different states, and a rigorous selection process ensured that they were among the top 5% of high school biology teachers nationwide. As evidence of their professionalism, 85% of the participants had advanced degrees, and they averaged 18 years' teaching experience. The schools they represented ranged from well-financed private institutions to large urban high schools with limited budgets; 55% of their schools have a minority population of 19–52%, and 25% of them provide lunch assistance for their student population. The intent of the *Institute* is to further develop their content and leadership skills so they can function as regional experts in advanced biology instruction.

The *Institute* incorporates high-level theoretical, laboratory, and computer work—including human and plant DNA polymorphisms, DNA sequencing, bioinformatics, and computer multimedia. Seminars presented by CSHL research scientists Richard McCombie, Rob Martienssen, Vivek Mittal, and David Helfman extended coursework to real-life research problems. A field trip to the American Museum of National History, in New York City, provided an opportunity to tour "The Genomic Revolution" exhibit with curator Rob DeSalle, to attend a symposium on "Teaching in the Genome Age," and to interact with Woodrow Wilson Fellows taking part in a similar institute at Princeton.

The *Institute* culminated with independent time during which participants were free to follow up on laboratory or computer work of particular interest to them, and to prepare curriculum materials for use in their own classrooms. Projects included identification of genes/transgenes in plants, bioinformatics, and Web page construction. One teacher brought bone material from a 1000-year-old South American mummy to the workshop. During the independent work period, she and two colleagues extracted and analyzed the mummy's mitochondrial DNA. Other teachers learned how to do electronic PCR or explored parallels between modern genetics and the ill-fated eugenics movement.

Pfizer Leadership participants and DNALC staff on the final day of the three week-long workshop.

DNA Interactive

In the spring, CSHL was abuzz with news of Jim Watson's plan for a five-part PBS television series, *Genetic Journey*, to celebrate the 50th anniversary of his discovery of the double helix. This will surely be the most notable public science event of 2003. Thus, we were thrilled when, in the fall, the DNALC was brought into the project to develop *DNA Interactive (DNAi)*, an interactive WWW "portal" through which teachers and students can enter a rich world of online resources about the DNA

revolution. Development of the site, as well as supporting videography and animations, is being funded by a $2 million grant from the Howard Hughes Medical Institute.

DNAi will be organized around five mini-courses that loosely follow the content of the TV series. Each mini-course will draw a variety of media elements into a common window, or "player"—including video interviews from *Genetic Journey*, schematic animations, high-resolution graphic animations, interactive problems, downloadable lesson plans and student workbooks, and connections to science education standards. *DNAi*'s unique content will be complemented by a revolutionary site structure. Working from the premise that teachers gain "ownership" of their curriculum by organizing knowledge drawn from a number of sources, *DNAi* will allow teachers to customize information and multimedia tools to best suit their unique instructional needs and preferences.

DNAi will employ a sophisticated content management system, which will be used by the DNALC staff to create the content of the site and allow teachers to customize the content according to their own needs. A user profile is stored on the *DNAi* server, and upon logging on, a teacher's customized content is assembled "on the fly" from content stored in the *DNAi* multimedia database. The site will be customizable on three levels. On the first level, teachers can create a custom class page, incorporating interactive page design of the sort offered on the start pages of Yahoo, MSNBC, and other online companies. The class page includes a message board to alert students to current work and assignments, a news feed of genetics articles from around the WWW, and a message board that at once anchors class discussions within wider discussions at the *DNAi* site.

On a second level, teachers will be able to edit modules within the mini-courses, shortening them or adding customized narrative. On a third level, teachers will be able to search, by keyword, all of the multimedia content at the site, then edit the returned items for display in a custom player. Each selected item can then be annotated by the teacher for class presentation or homework assignment. This will give biology teachers the multimedia equivalent of Powerpoint—a simple presentation builder linked to a database of thousands of searchable video clips, animations, molecular graphics, photographs, and narrative elements.

DNAi represents a tremendous opportunity for the DNALC to make good use of the sophisticated Internet publishing capabilities it has built over the past several years. We believe that *DNAi* will introduce a new way for biology teachers and students to interact on the WWW, and we expect it to draw between 500,000 and 1 million visitors per month. Upon publication of *DNAi*, in spring 2003, we will be positioned for additional large-scale projects in biological multimedia.

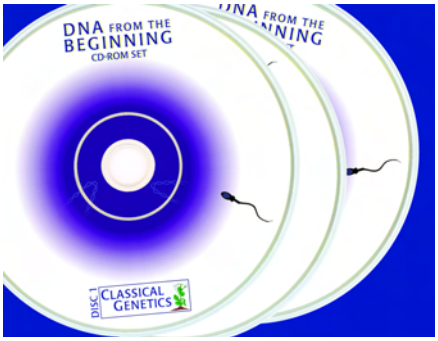
Our WWW Domain Expands

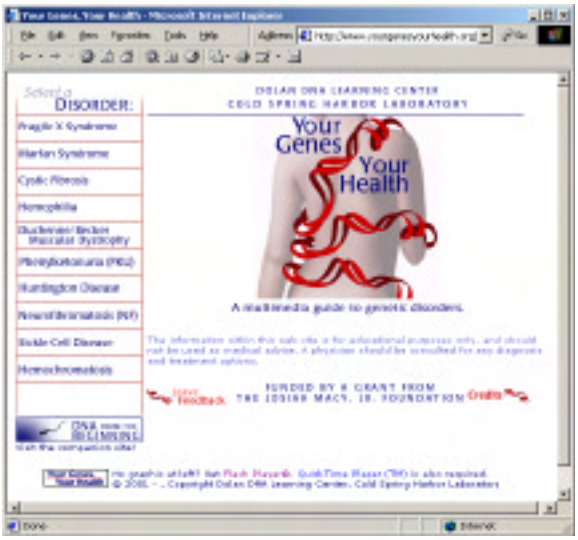
The Gene Almanac WWW site is a portal to a number of content sites developed and managed by the DNALC. In 2001, the sites received a combined visitation of 1.7 million, an increase of 54% over the previous year. *DNA from the Beginning* is still the most popular site, but within months of its launch, the new site *Your Genes, Your Health* was poised to overtake it in popularity.

In anticipation of future growth, we improved our site architecture and updated our server hardware. We also implemented common sense-domain names, which will aid visitors in finding our sites:

Gene Almanac: http://www.genealmanac.org
DNA from the Beginning: http://www.dnaftb.org
Your Genes, Your Health: http://www.yourgenesyourhealth.org
Archive of the American Eugenics Movement: http://www.eugenicsarchive.org
Genetic Origins: http://www.geneticorigins.org
Bioservers: http://www.bioservers.org

In December 2000, we posted the final chapters of our Internet-accessible tutorial *DNA from the Beginning* (*DNAFTB*). To make this work available to those without fast Internet connections, in November we released a CD-ROM version for stand-alone play. Animation, video, and photographic resources of the 41-chapter work are so extensive that they fill three disks. The set is available at our WWW site for $49.99, using PayPal to expedite credit card purchases.





Above: Postcard to promote the *DNA from the Beginning* CD set. At right : The *Your Genes, Your Health* web site has become the most popular component of the DNALC web site.

With completion of *DNAFTB*, the *Biomedia* staff began developing a companion site entitled *Your Genes, Your Health* (*YGYH*). A multimedia guide to genetic disorders, *YGYH* is targeted at patients and families who are urgently looking for understandable information about specific genetic disorders. The site deals with relatively common disorders, and focuses on how ongoing molecular genetics research is improving diagnostics and the types of treatment that are currently available.

YGYH was launched in April with Fragile X syndrome, followed by Marfan syndrome, cystic fibrosis, hemophilia, and Duchenne/Becker muscular dystrophy. The hemophilia module was a Yahoo Web Site pick of the week. Modules on phenylketonuria, Huntington disease, neurofibromatosis, sickle cell, hemochromatosis, thalassemia, Tay-Sachs, Alzheimer, Down syndrome, and either asthma or diabetes will follow in 2002. Each disorder starts with short facts for quick browsing. More in-depth information is provided by animations on the disorder's cause, inheritance, and diagnosis. Video interviews with patients, health-care providers, and researchers provide insiders' perspectives on having and treating genetic disorders. Based on feedback received from this web site, these insiders' perspectives are extremely helpful for the newly diagnosed. Each disorder also has links to support groups and foundations, which advise us during development.

In February 2001, the *Biomedia* group obtained a 3-year, $850,000 grant from the National Institutes of Health to build a multimedia Internet site called *Inside Cancer*. The web site is geared toward the general public and will be especially useful to 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. The *Inside Cancer* site will have five modules: (1) *What is Cancer* shows how cancers develop from a single cell. (2) *Causes & Prevention* identifies behaviors and environmental factors that increase cancer incidence. (3) *Diagnosis & Treatment* explains traditional and experimental strategies for identifying and fighting cancer. (4) *Cancer in the Laboratory* explains key experiments that have advanced our understanding of cancer at the cellular and molecular levels. (5) *Pathways to Cancer* is a three-dimensional tour showing how growth signals are relayed from the cell exterior to the nucleus and how they are perturbed in cancer cells.

Eugenics Image Archive

The *Image Archive on the American Eugenics Movement* Web Site continues to be a popular resource. In 2001, the *Archive* received 84,000 visitors who requested 428,000 documents. We increased the holdings of the *Archive* by nearly 50% when we photographed 700 additional objects from the CSHL

Archives and two other sites. At the International Center of Photography (ICP) in Manhattan, we were able to gather an eclectic set of images from the exhibition *Perfecting Mankind: Eugenics and Photography*. We were very excited to receive permission to access collections at the University College, London, where we spent a frenetic two days in October in the collections of Francis Galton, Karl Pearson, and Lionel Penrose. It was thrilling to see Galton's notebooks for *Hereditary Genius*, the work that started the eugenics movement; data from his work on fingerprint analysis and composite portraiture; and personal correspondence with his cousins Charles and Leonard Darwin.

To allow people to have the sense of working with original documents that represent the objectives and methods of the eugenics movement, about half of the *Archive* consists of photographs of rare documents and correspondence. However, the tex content of these photographs cannot be searched. Thus, in 2001 we began a major project to transcribe each written document in the collection. Under this system, each image of a document has a corresponding text file, which can be searched along with titles. Thus, a search returns both the archival photograph and a corresponding text file, which is easier to read and from which quotations can be easily extracted.

On May 6–8, we held the first of three Banbury meetings to be sponsored under our grant from the National Human Genome Research Institute. *American Eugenics and the New Biology: Perspectives and Parallels* aims to familiarize "opinion leaders" about this dark saga in American science. The meeting drew 31 participants from diverse fields, including family genetics, education, ethics, journalism, government, industry, and philanthropy. Sessions on the history and lessons learned from the eugenics movement included presentations by four members of our Advisory Panel: Gar Allen, Elof Carlson, Paul Lombardo, and Steve Selden.

Dean Hamer of the National Cancer Institute discusses the genetics of human behavior with participants at the first *American Eugenics and the New Biology* meeting in May.

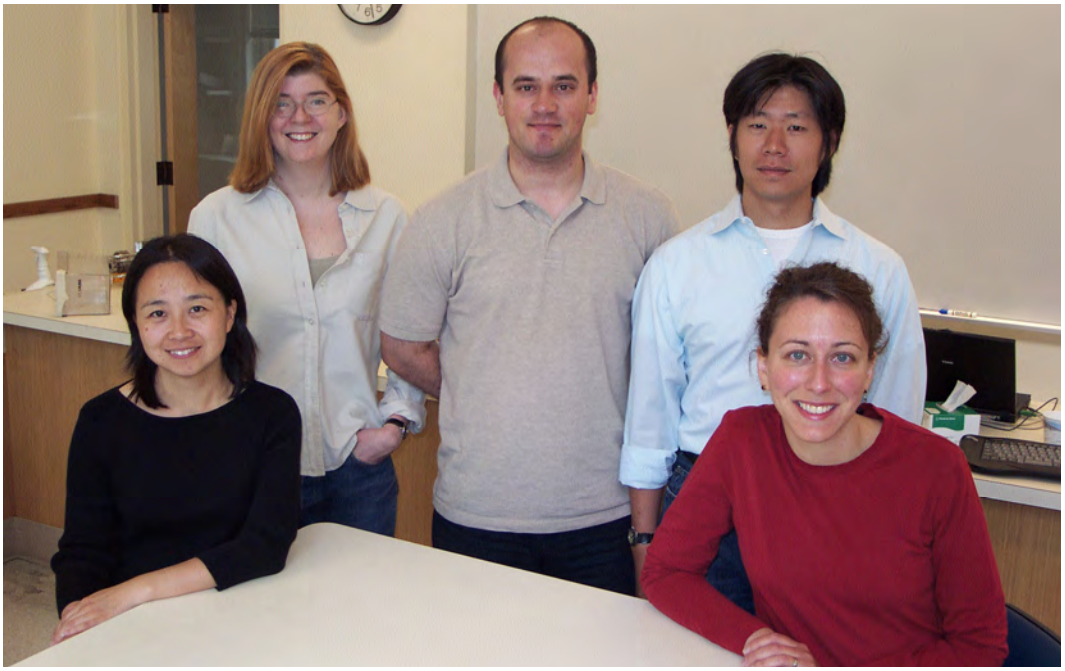
Staff and Interns

We were sorry to bid farewell to several staff members in 2001. Vin Torti, the Chief Development Officer for the DNALC, left in July for a position at Long Island Institute of Technology. He is currently working as the development officer at Winthrop Hospital. Our scientific coordinator, Veronique Bourdeau, went on maternity leave in September and had a baby boy. The whole family then moved to Montreal, where Vero's husband took a position at the local university. In the future, we hope to work with Vero to bring some of the DNALC's programs to the Great White North. After contributing key writing to the *DNAFTB* and *YGYH* WWW sites, Susan Conova left in December for a position in the external relations department of Columbia Health Science, where she is a science writer and communicator.

With the increase in physical space at the DNALC, we were able to plan for a new exhibit. Bronwyn Terrill joined us in February to develop the new DNALC exhibit *The Genes We Share*, which will be open to the public in 2002. Bronwyn, our Australian import, has a background in science communication and museum exhibit development and has worked at several major science museums and organizations in Australia.

The *Biomedia* group expanded in response to the DNALC's growing web presence. Wen-Bin (Bin) Wu started in April as a new multimedia designer. He has a background in print design and a masters degree in computer design from Rochester Institute of Technology. Bin's eye for simplicity and elegance and his attention to detail have brought a new look to our web sites. Adrian Arva was an eagerly awaited addition to the *Biomedia* staff. Adrian responded to our on-line advertisement for a computer programmer in September of 2000. His interest in web site development and bioinformatics, and his medical/science background, made him an ideal choice for our web programmer. It took a little longer for the U.S. and Romanian governments to agree with our choice, but Adrian finally began working at the DNALC in May.

The middle-school instructional group also saw changes. In September, we were thrilled to welcome Tricia Maskiell back to the middle-school staff. Tricia had left her position at the DNALC in 2000 when her husband's job required a move to New Hampshire. One of the first things Tricia did



New employees, from left to right: Hong Zhou, Bronwyn Terrill, Adrian Arva, Wen-Bin Wu, and Jennifer Aizenman.

when they moved back to New York in 2001 was to contact the DNALC and take on a part-time position. Danielle Sixsmith, another middle-school teacher, went on maternity leave this summer, and returned in November with a new addition to her family—a baby girl. Danielle is working part-time, and will head up DNALC West, the satellite facility we are currently developing with the North Shore–Long Island Jewish Health System.

To make full use of our enlarged teaching facilities, in the fall we recruited Jennie Aizenman and Hong Zhou to the instructional group. In addition to teaching high school classes, Jennie will develop new labs for the students. She received her Ph.D. in molecular microbiology and immunology from the Johns Hopkins University School of Public Health and did postdoctoral work at Rockefeller University. Hong helps manage our high school interns and our *DNA Sequencing Service*. The wife of CSHL scientist Jerry Yang, Hong has a masters degree in molecular biology and has worked in science labs in China and in the United States.

Veteran interns Yan Liang Huang (Harborfields High School) and Janice Lee (Oyster Bay High School) assisted us throughout the year training new interns and working in our new laboratory classrooms and prep labs. Janice is researching RNAi in fission yeast with CSHL's Tom Volpe (Delbruck). She also completed her research of PCR analysis of the CF1 mutation in *Arabidopsis* and, over the summer, helped train the younger interns.

Other veteran interns, whom we miss tremendously, left mid-year to pursue their scientific interests. Among them, Caroline Lau (Syosset High School) was chosen for the prestigious CSHL "Partners for the Future" program. She has been teamed with David Jackson (Delbruck), and is studying cell-to-cell communication in *Arabidopsis thaliana*. Rebecca Shoer (Syosset High School) is researching new protocols for microarray techniques with Vivek Mittal at the Woodbury Genome Center. Jordan Komisaro (Long Beach High School) is researching *Arabidopsis* genetics with Rob Martienssen (Delbruck). Daniel Goldberg (Half Hollow Hills East) has joined a researcher at NS-LIJ. Rebecca (Becca) Yee, a former high school intern at the DNALC, used her summer break from Wellesley College to help instruct and coordinate new interns. Her expertise and skill were greatly appreciated during the hectic workshop season. Visiting summer interns were Daniel DeRoulet, Daniel Davison, Brendan O'Kane, and Dennis O'Kane.

Processing and sequencing mitochondrial DNA sent from around the country has become an important responsibility of the intern force. Sirish Kondabolu (Half Hollow Hills High School) and Jonathan Mogen (Half Hollow Hills High School), along with senior intern Andrew Diller, have kept pace beautifully as we continue to meet the increasing demand on the DNALC's on-site sequencing program.

Joining the intern crew in the spring were Jared Winoker (Syosset High School), Marie Mizuno (Cold Spring Harbor High School), Benjamin Blond (Syosset High School), and Kunal Kadakia (Syosset High School). Jared and Kunal have been studying the allelic frequency of the *Alu* insertion on chromosome 16. Benjamin has been working with Jennie Aizenman on mutagenesis of enhanced GFP and BFP proteins. Marie is researching apoptosis with Yuri Lazebnik (Hershey).

Fall 2001 newcomers included Eric Paniagua (Long Island School for the Gifted), Saroja Bangaru (Long Island School for the Gifted), Michelle Louie (Kings Park High School), Hala Mostafa (Kings Park High School), Gerad Ryan (Kings Park High School), Jarrett Linder (Half Hollow Hills High School), Alex Witkowski (Cold Spring Harbor High School) and Wayne Chiang (Cold Spring Harbor High School).

The *Biomedia* group also had talented and enthusiastic interns to help with the day-to-day operations of web site production. Tracy Mak (Syosset High School) and Felix Hu (Northport High School) as returning high school interns were indispensable in taking care of all the details. Felix was extremely helpful over the summer with software and computer installations. Summer college interns Eun-Sook Jeong (C.W. Post), Kun-Feng Chen (C.W. Post), and Matthijs Muller (Free University of Amsterdam, Netherlands) helped with initial production of the *Your Genes, Your Health* Web Site. We also welcomed Watson School graduate student Elizabeth Thomas to assist us with WWW development.

2001 Workshops, Meetings, and Collaborations

January 16–18	National Institutes of Health, *A Decade of ELSI Research* Conference, Bethesda, Maryland
January 22–23	*Your Genes, Your Health* interview, Katherine Clapp, FRAXA Research Foundation, Newburyport, Massachusetts
January 24	*Your Genes, Your Health* interview, Debbie Stevenson, FRAXA Research Foundation, National Fragile X Foundation, New York, New York
January 25	Site visit by Rebecca Burkhadt, Long Island Business News
January 29	*Your Genes, Your Health* interview, Dr. Ted Brown, New York State Institute for Basic Research in Developmental Disabilities, Staten Island, New York
January 30	Site visit to American Museum of Natural History and the International Center of Photography, New York, New York
February 13	Site visit by Axel Jahns, Brinkmann Instruments
February 15–20	American Association for the Advancement of Science Annual Meeting, San Francisco, California
February 16–25	Site visit to the National Institute of Education, Singapore
March 14	Site visit by Dr. Rod Wing, Dr. Jerry Trapnell, and Dr. Harold Cheatham, Clemson University, South Carolina
March 18	Presentation for students and parents, Parrish Art Museum, Southampton, New York
March 20	Site visit by Dr. James Bonacum, American Museum of Natural History, New York, New York
March 22	Howard Hughes Medical Institute, *New York City Genes* teacher training, York College, Queens, New York
March 22–25	National Science Teachers Association Annual Meeting, St. Louis, Missouri
March 29	Workshop presentation for National Institute of Science Meeting, Atlanta, Georgia
March 30	National Human Genome Research Institute ELSI Project, *Eugenics Image Archive*, collection visit to International Center of Photography, New York, New York
	Your Genes, Your Health interview, Dr. Richard Devereux, New York Presbyterian Hospital, New York, New York
April 4	Site visit by Judy Winkler, Invention Factory Science Center, Trenton, New Jersey
	National Institute of Social Sciences Board Meeting, New York, New York
	Presentation for *Career Day* at Sayville High School, Sayville, New York
April 6	*Your Genes, Your Health* interview, Julie Kurnitz, New York, New York
April 13	Laboratory for Pine Creek and George Washington High Schools, Colorado Springs, Colorado
April 20	Site visit to American Museum of Natural History, New York, New York
April 25	National Institute of Social Sciences Meeting, Harvard Club, New York, New York
April 26	Site visit by Wendy Law and David Masterman, Fred Hutchinson Cancer Research Center, Seattle, Washington
April 28	Presentation for students and parents, Planting Fields Arboretum State Historic Park, Oyster Bay, New York
May 1	*Great Moments in DNA Science* Honors Students Seminar, CSHL
May 4	*Your Genes, Your Health* interview, Dr. Allan Rubenstein, Mount Sinai School of Medicine, New York, New York
May 6–8	National Institutes of Health ELSI conference, *American Eugenics and the New Biology: Perspective and Parallels*, Banbury Center, CSHL
May 7	*Great Moments in DNA Science* Honors Students Seminar, CSHL
May 10	Site visit by Dr. Peter Bruns, Vice President for Grants and Special Programs, Howard Hughes Medical Institute
May 11	Site visit by Jesse Raiford, Maximum Science Studio
May 14	Site visit by Christine Herbes-Sommers and Sandy Haller, *Human Race* project, California Newsreel
May 15	*Great Moments in DNA Science* Honors Students Seminar, CSHL
	Your Genes, Your Health interview, Cara Kaek and daughter Noel, Long Island, New York
May 16	Site visit by Robert M. Frehse, Jr., Vice President and Executive Director, The Hearst Foundation
May 18–20	American Society for Microbiology Education Conference, Orlando, Florida
May 22	Site visit by Dean Madden and John Schollar, University of Reading, United Kingdom
May 28–June 1	*DNA Science* Workshop, National Institute of Education, Singapore
May 29	*Your Genes, Your Health* interview, Paul Brayshaw, Washington D.C.
May 30	*Your Genes, Your Health* interview, Price family, Washington D.C.
	Your Genes, Your Health interview, Dr. Katherine High, Children's Hospital of Philadelphia, Pennsylvania
June 8	Dolan DNA Learning Center Building Dedication
June 11–13	Teacher training workshop for Singapore Ministry of Education

June 12	*Your Genes, Your Health* interview, Dr. Catherine Manno, Children's Hospital of Philadelphia, Pennsylvania
June 15	Site visit and interview by Scott Feldman,News 12 Long Island
June 18–22	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Oklahoma Medical Research Foundation,Oklahoma City, Oklahoma
June 25–29	*Fun With DNA* Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Science Workshop, DNALC
July 2–20	Pfizer *Leadership Institute in Human and Molecular Genetics*, DNALC
July 6	Site visit by Karen Arenson, *The New York Times*
July 7	Howard Hughes Medical Institute, *New York City Genes* teacher training, American Museum of Natural History, New York, New York
July 9–13	*Green Genes* Workshop, DNALC
	Genomic Biology & PCR Minority Workshop, Central Islip High School, New York
July 16–20	*Fun With DNA* Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Science Minority Workshop, Brooklyn Technical High School,New York
July 18	*Your Genes, Your Health* interview, Dr. Clement Ren, Stony Brook University Medical Center, New York
July 23–27	*Fun With DNA* Workshop, DNALC
	Green Genes Workshop, DNALC
	DNA Science Minority Workshop, John F. Kennedy High School, Bronx, New York
	Genomic Biology & PCR Workshop, DNALC
	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Salk Institute for Biological Studies, La Jolla, California
July 25	*Your Genes, Your Health* interview, Dr. Jane Halperin, genetic counselor, New York, New York
July 26	*DNA from the Beginning* interview, Dr. Nathaniel Comfort,Baltimore, Maryland
July 30–August 3	*Fun With DNA* Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Science Workshop, DNALC
	DNA Science Workshop, Brooklyn Technical High School, New York
	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop, Fred Hutchinson Cancer Research Center, Seattle, Washington
July 31	*Your Genes, Your Health* interview, Suzanne Burger, Westchester County, New York
August 6–10	*Green Genes* Workshop, DNALC
	DNA Science Workshop, DNALC
August 9	*Your Genes, Your Health* interview, Dr. Alfred Spiro, Albert Einstein College of Medicine, Bronx, New York
	DNA from the Beginning interview, Dr. Scott Gilbert,Swarthmore College,Pennsylvania
August 13–17	*Fun With DNA* Workshop, DNALC
	Genetic Horizons Workshop, DNALC
	Genomic Biology & PCR Workshop, DNALC
	Howard Hughes Medical Institute, *Vector Bioinformatics* Workshop,Trudeau Institute, Saranac Lake, New York
August 20–24	*Fun With DNA* Workshop, DNALC
	World of Enzymes Workshop, DNALC
	DNA Science Workshop, DNALC
August 22	Site visit by Michael Dowling, Roy Zuckerberg, and Dan DeRoulet, North Shore-Long Island Jewish Health System
August 23	*Your Genes, Your Health* interview, Dr. Selma Snyderman, Mount Sinai School of Medicine, New York, New York
August 27	Site visit by Michael Gilman and Gregory Peterson, Biogen, Cambridge, Massachusetts
	Your Genes, Your Health interview, Erin Buckley, Huntington, New York
August 31	Site visit by Clare Matterson, Wellcome Trust, London, UK, and D. Burke, Pricewaterhouse Coopers
August 27–31	*Fun With DNA* Workshop, DNALC
	DNA Science Workshop, DNALC
September 7–9	Workshop presentation for students taking part in the *Human Race* project,Allston, Massachusetts
September 18	Site visit by David Bowtell and Joe Sambrook, Peter MacCallum Cancer Institute, East Melbourne, Australia

September 20	Gateway Institute for Higher Education Coordinator Meeting, City College, New York, New York
September 21	*Your Genes, Your Health* interview, Dr. Chris Ross, Johns Hopkins University School of Medicine, New York, New York
	Your Genes, Your Health interview, Suzanne Doggett, Huntington's Disease Society of America, New York, New York
	Your Genes, Your Health interview, Nancy and Barry Goldring, Huntington's Disease Society of America, New York, New York
September 30–October 1	National Human Genome Research Institute ELSI Project, *Eugenics Image Archive*, Editorial Advisory Panel Meeting, Banbury Center, CSHL
	Your Genes, Your Health interview, Pat Ryan, Carolina Biological Supply Company, Burlington, North Carolina
October 2	*Your Genes, Your Health* interview, Dr. Kusum Viswanathan, Brookdale University Hospital and Medical Center, New York
	Your Genes, Your Health interview, Dr. Kenneth Rivlin, Brookdale University Hospital and Medical Center, New York
October 3	Inter School Exchange Faculty Dinner, DNALC
October 4	Site visit by Dr. Michael Schroeder, Eppendorf AG, Hamburg, Germany
October 5	Site visit by Piero Benedetti, Padova University, Italy
October 15	Site visit by Linda Winston, American Museum of Natural History, New York, New York
October 17	Presentation for *Long Island School to Career Partnership*, Huntington Hilton, New York
October 18	*Inside Cancer* interview, Dr. Scott Lowe, CSHL
October 18–19	Exhibit interview, Dr. Matt Ridley, International Center for Life, Newcastle, United Kingdom
	Inside Cancer interview, Dr. Judah Folkman, Harvard Medical School, Massachusetts
October 20	*Inside Cancer* interview, Dr. Doug Hanahan, University of California-San Francisco
October 22–26	National Human Genome Research Institute ELSI Project, *Eugenics Image Archive*, collection visit to University College, London, United Kingdom
October 25	*Your Genes, Your Health* interview, Maya Priest, New York, New York
October 29–31	Howard Hughes Medical Institute Precollege Directors Meeting, Chevy Chase, Maryland
November 6	*Inside Cancer* interview, Dr. Mike Wigler, CSHL
November 7–10	National Association of Biology Teachers Annual Meeting, Montreal, Quebec, Canada
November 14	Site visit to Biogen, Cambridge, Massachusetts
November 15	Site visit by Barbara Speziale, Clemson University, South Carolina
November 16	Site visit by Kip Powers and David Tesseo, Science Center of Southeastern Connecticut, New London
November 20	Site visit by Marcia Welsch, Elaine Sands and Gayle Insler, Adelphi University, Garden City, New York
November 28	Site visit by Katie Barbour and Doug Crain, Flying Colors Media
December 3	Site visit by Ann McDermott, Oncogene Pharmaceuticals, Melville, New York
	Site visit to New York Institute of Technology, Old Westbury, New York
December 4–5	National Human Genome Research Institute ELSI Review Panel, Bethesda, Maryland
December 7	Site visit by Dr. Sheldon Karnilow and Mike DeStio, Half Hollow Hills School District, Dix Hills, New York
December 12	Museum exhibit interview, Syd Mandelbaum, Cedarhurst, New York
December 18	Site visit to Biogen, Cambridge, Massachusetts

Sites of Major Faculty Workshops 1985–2001

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

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

	Cold Spring Harbor High School	1985,1987
	DeWitt Middle School,Ithaca	1991,1993
	DNA Learning Center	1988–1995, 2001
	DNA Learning Center	**1990,1992,1995,2000**
	DNA Learning Center	*1990–1992*
	Fostertown School, Newburgh	*1991*
	Huntington High School	1986
	Irvington High School	1986
	Junior High School 263, Brooklyn	*1991*
	Lindenhurst Junior High School	*1991*
	Mt. Sinai School of Medicine, New York	1997
	Orchard Park Junior High School	*1991*
	Plainview-Old Bethpage Middle School	*1991*
	State University of New York, Purchase	1989
	State University of New York, Stony Brook	1987–1990
	Titusville Middle School, Poughkeepsie	*1991,1993*
	Wheatley School, Old Westbury	1985
	U.S. Military Academy, West Point	**1996**
	Stuyvesant High School, New York	1998–1999
	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
UTAH	University of Utah, Salt Lake City	1993
	University of Utah, Salt Lake City	**1998**
	University of Utah, Salt Lake City	**2000**
VERMONT	University of Vermont, Burlington	1989
VIRGINIA	Eastern Mennonite University, Harrisonburg	1996
	Jefferson School of Science, Alexandria	1987
	Mathematics and Science Center, Richmond	1990
	Mills Godwin Specialty Center, Richmond	1998
WASHINGTON	**University of Washington, Seattle**	**1993,1998**
	Fred Hutchinson Cancer Research Center, Seattle	1999, 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
SWEDEN	Kristineberg Marine Research Station, Fiskebackskil	1995

Dolan DNA Learning Center 2001 Grants

Federal Grants		Term of Grant	2001 Funding
National Institutes of Health ELSI Research Program	Creation of a Digital Image Archive on the American Eugenics Movement	3/98-3/01	$227,994
National Institutes of Health	Creation of Inside Cancer	1/01-12/03	$240,100
National Science Foundation	A Partnership to Develop Advanced Technology Units on Genomic Biology	8/97-7/01	$ 47,644
Department of Energy	The Science and Issues of Human DNA Polymorphisms: An ELSI Training Program for High School Biology Teachers	1/97-9/01	$ 2,203
Non-Federal Grants			
Howard Hughes Medical Institute	Precollege Science Education Initiative for Biomedical Research Institutions	9/99-8/03	$154,486
Josiah Macy, Jr. Foundation	*DNA from the Beginning* and *Your Genes, Your Health*	10/97-9/02	$268,400
Pfizer Foundation	Leadership Institute in Human and Molecular Genetics	1/01-12/01	$ 50,733

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

Bellmore-Merrick Central High School District	$5,305
Bethpage Union Free School District	$1,425
Brooklyn	$250
Commack Union Free School District	$250
Community School District #29	$33,375
East Meadow Union Free School District	$5,900
East Williston Union Free School District	$1,400
Elwood Union Free School District	$3,115
Farmingdale Union Free School District	$980
Friends Academy	$6,940
Garden City Union Free School District	$5,545
Great Neck Union Free School District	$6,515
Green Vale School	$625
Harborfields Central School District	$9,595
Half Hollow Hills Central School District	$4,000
Hebrew Academy	$1,325
Jericho Union Free School District	$6,075
Lawrence Union Free School District	$6,230
Locust Valley Central School District	$16,000
Merrick Union Free School District	$1,125
New York City School District #17	$250
Northport-East Northport Union Free School District	$6,160
Old Westbury School of the Holy Child	$1,650
Port Washington Union Free School District	$12,710
Rockville Center Union Free School District	$4,525
St. Dominic Elementary School	$2,450
St. Edwards	$2,025
South Huntington Union Free School District	$5,040
Syosset Central School District	$20,250

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

Bethpage Union Free School District	$1,100
Commack Union Free School District	$1,100
East Meadow Union Free School District	$2,200
Friends Academy	$1,100
Garden City Union Free School District	$1,100
Great Neck Union Free School District	$2,200
Green Vale School	$1,100
Half Hollow Hills Central School District	$1,100
Herricks Union Free School District	$1,100
Island Trees Union Free School District	$1,100
Jericho Union Free School District	$1,100
Lawrence Union Free School District	$1,100
Levittown Union Free School District	$1,100
Locust Valley Central School District	$1,100
North Shore Central School District	$1,100
Oceanside Union Free School District	$1,100
Plainedge Union Free School District	$2,200
Plainview-Old Bethpage Central School District	$1,100
Portledge School	$1,100
Port Washington Union Free School District	$1,100
Ramaz School	$1,100
Roslyn Union Free School District	$1,100
Sachem Central School District	$2,200
South Huntington Union Free School District	$2,200
Syosset Central School District	$1,100
West Hempstead Union Free School District	$1,100

Dolan DNA Learning Center
Cold Spring Harbor Laboratory
Cold Spring Harbor, New York 11724

Located at:
334 Main Street (Route 25A)
Cold Spring Harbor Village

Phone: (516)367-5170
Fax: (516) 367-5182
Email: dnalc@cshl.org
On the Web: http://www.dnalc.org