# LIFE SCIENCES



# HIGH SCHOOL HONORS PROGRAM



OCTOBER 1987




Lawrence Berkeley Laboratory • University of California



Prepared for U.S. Department of Energy under Contract No. DE-AC03-76SF00098

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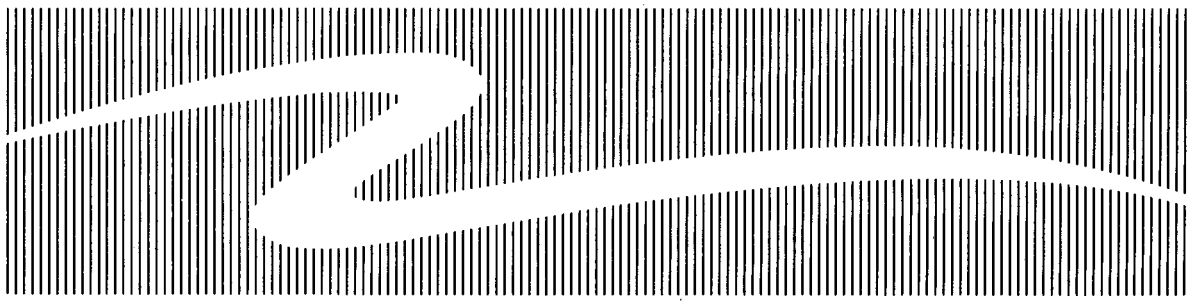
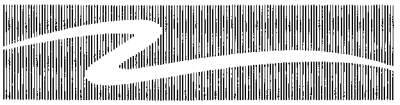


# HIGH SCHOOL HONORS PROGRAM

June 21 – July 3, 1987

Lawrence Berkeley Laboratory
University of California
Berkeley, California

LIFE SCIENCES



HIGH SCHOOL HONORS PROGRAM

# Foreword

The High School Honors Program is aimed at placing some of our most promising high school students in an environment that is both intellectually challenging and culturally inspiring. The students are exposed to a wide variety of topics and are encouraged to discuss both the advances and social implications of science. It is our firm belief that education in its broadest sense is a process by which curiousity is increased, eagerness for knowledge is encouraged, and fascination with what remains unknown is developed. The process also reflects our conviction that it is only through genuine interactions between sensitive, intelligent and tolerant human beings that we will create the world we all wish to live in.

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# Contents

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# Introduction: Goals and Features of the Program

- **Goals of the Program**

  Assist students to recognize why modern biology requires a sound basis in chemistry, physics, and mathematics

  Convey to the students an understanding of the impacts of modern biology on the economy, society and environment

  Provide a forum for the exchange of ideas between the students and leading life scientists

  Offer to the students hands-on experience with state-of-the-art instrumental techniques used in modern biology

  Introduce students to some of the critical thinking skills used in scientific research, particularly as these skills apply to research in modern biology

- **Features of the Program**

  Lectures, tutorials, discussion

  Lab research assignments for hands-on work

  Pairing students with staff advisors

  Completion of a written summary of research project

- **Typical Daily Schedule**

| | |
|---|---|
| 8:30 – 9:15 a.m. | Group assembly, lecture topic |
| 9:15 – 10:00 a.m. | Group discussion on lecture issues |
| 10:00 – 10:30 a.m. | Break |
| 10:30 – 11:15 a.m. | Second lecture topic |
| 11:15 – 12:00 noon | Group discussion on lecture issues |
| 12:00 – 1:00 p.m. | Lunch · travel to lab assignments |
| 1:15 – 5:00 p.m. | Lab assignments |
| 5:10 – 5:30 p.m. | LBL shuttles depart from LBL to Clark Kerr Center |
| 5:30 – | Recreational, social and offsite learning program |

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HIGH SCHOOL HONORS PROGRAM

# 1987 LBL/UC Seminars

Lawrence Berkeley Laboratory
Building 50 Auditorium

## Monday, June 22

**Alexandre Quintanilha**
Introduction
10:00am – 10:30am

**Bruce Ames**
Cancer Causing Chemicals
10:30am – 12pm

## Tuesday, June 23

**Melvin Calvin**
Energy from the Sun
8:30am – 10:00am

**Gunther Stent**
Development of a Simple Nervous System
10:30am – 12:00pm

## Wednesday, June 24

**Douglas Clark**
Modern Biotechnology:
Scope & Recent Developments
8:30am – 10:00am

**Mina Bissell**
Differentiation and Cancer
10:30am – 12:00pm

## Thursday, June 25

**Alexander Nichols**
Macromolecules and Cells in Heart Disease
8:30am – 10:00am

**Jay Levy**
The AIDS Virus:
Its Role in the Disease
10:30am – 12:00pm

## Friday, June 26

**LBL Staff**
Laboratory tours for students
8:30am – 10:30am

**Bertram Lubin**
Sickle Cell Anemia:
Causes and Treatment
10:30am – 12:00pm

## Monday, June 29

**John Hearst**
Molecular Machines of Modern Biology
8:30am – 10:00am

**Peter Schultz**
Protein Engineering
10:30am – 12:00pm

## Tuesday, June 30

**Edward Alpen**
Natural Radioactivity,
Background Radiation and Man
8:30am – 10:00am

**Paul Silverman**
Inhibition of Blood Cell Production by Parasites
10:30am – 12:00pm

## Wednesday, July 1

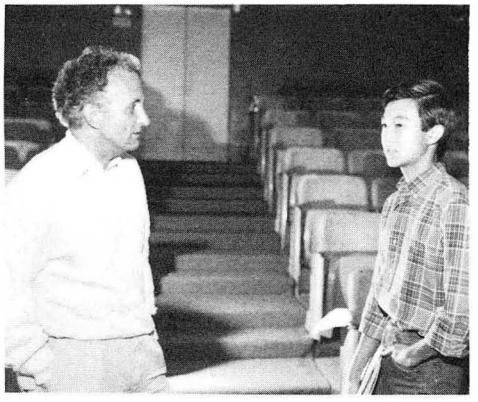
**Edward Penhoet**
Biotechnology and the Future of Pharmaceuticals
8:30am – 10:00am

**Lewis Feldman**
Plant Development
10:30am – 12:00pm

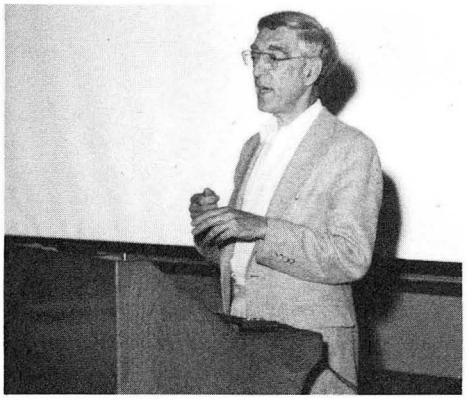
## Thursday, July 2

**Thomas Budinger**
How to Look Inside the Human Brain and Heart
8:30am – 10:00am

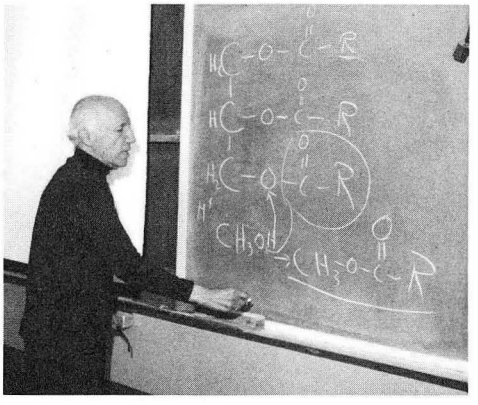
**Alexandre Quintanilha**
The Role of Oxygen in Stress
10:30am – 12:00pm



**Alexandre Quintanilha**
Project Manager of High School Honors Program discusses life sciences topics with student.

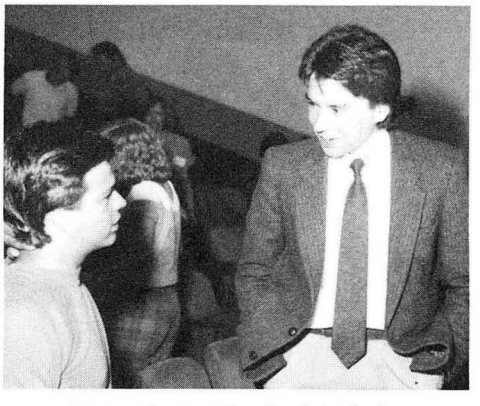


**Bruce Ames**
Professor and Chairman
Biochemistry Department
University of California, Berkeley
Biology & Medicine Division, LBL



**Melvin Calvin**
Nobel Laureate
Emeritus Professor of Chemistry
University of California, Berkeley
Chemical Biodynamics Division, LBL

**Mina Bissell (center)**
Senior Research Scientist
Biology and Medicine Division, LBL

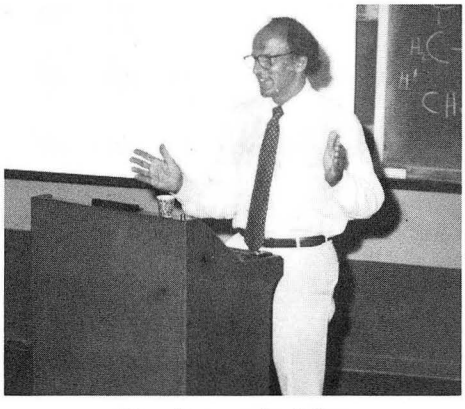


**Douglas Clark (right)**
Assistant Professor of Chemical Engineering
University of California, Berkeley
Applied Science Division, LBL

**Gunther Stent**
Professor of Molecular Biology
University of California, Berkeley

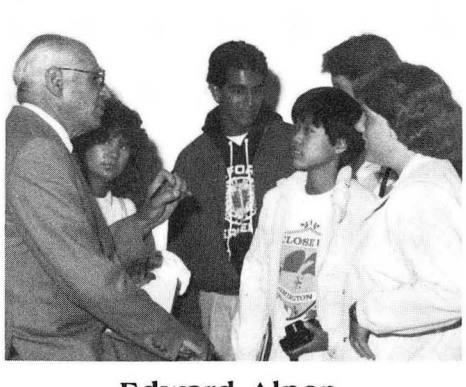
**Lewis Feldman**
Associate Professor of Botany
University of California, Berkeley

**Jay Levy**
Professor of Medicine
University of California, San Francisco

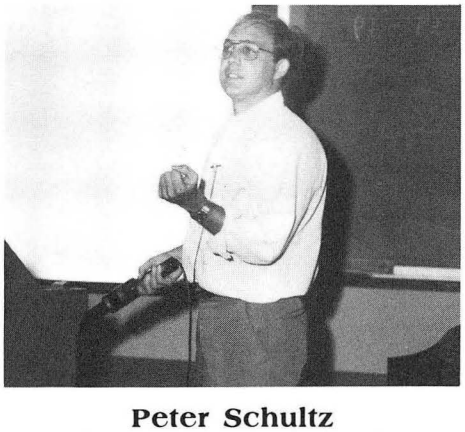


**Bertram Lubin**
Director of Research
Children's Hospital, Oakland
Applied Science Division, LBL

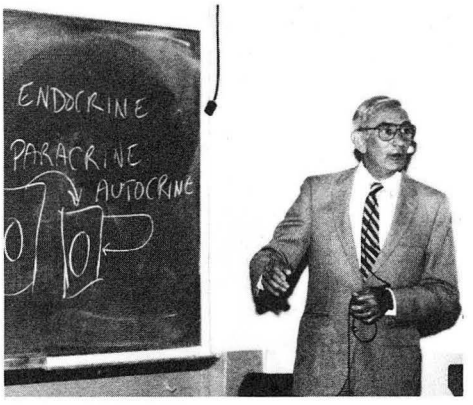
**John Hearst**
Professor of Chemistry
University of California, Berkeley
Chemical Biodynamics Division, LBL



**Edward Alpen**
Professor of Biophysics
University of California, Berkeley
Biology and Medicine Division, LBL

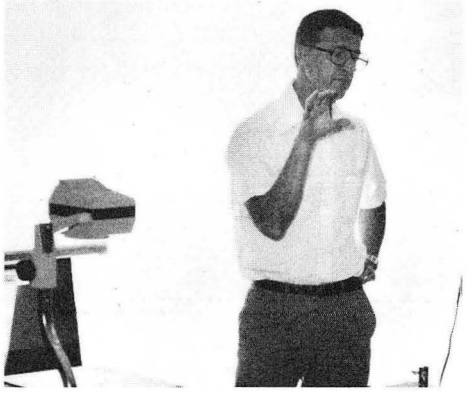


**Peter Schultz**
Assistant Professor of Chemistry
University of California, Berkeley
Materials and Chemical Sciences
Division, LBL

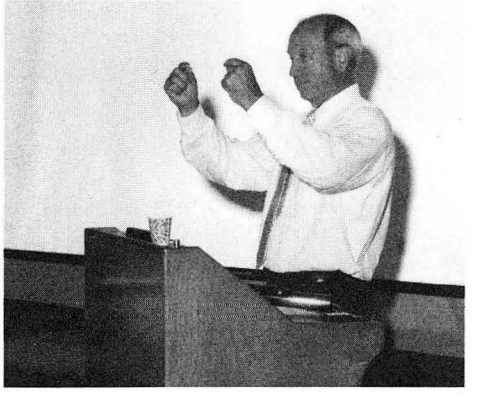



**Paul Silverman**
Acting Associate Director
Biology and Medicine Division, LBL

**Alexandre Quintanilha**
Adjunct Associate Professor of Physiology
University of California, Berkeley
Applied Science Division, LBL



**Alexander Nichols**
Professor of Biophysics
University of California, Berkeley
Biology and Medicine Division, LBL



**Thomas Budinger**
Professor of Electrical Engineering
and Computer Science
University of California, Berkeley
Biology and Medicine Division, LBL

**Patricia Olson**
Vice President for Research and
Development
Chiron Corporation

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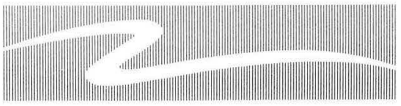


HIGH SCHOOL HONORS PROGRAM

# Laboratory Assignments

High School Honors Program laboratory assignments were scheduled for four hours each day and were designed to provide the maximum possible interaction with life sciences researchers and use of laboratory equipment. Emphasis was placed on the idea of promoting scientific curiosity through introduction to complex biological questions. Each laboratory assignment illustrated an important area of biological study. Students were expected to work together in research teams to set up experiments, collect data, and to analyze research results.

Students continued in a single laboratory assignment for the two weeks. These laboratory assignments are described on the following pages and the reports and comments prepared by the students follow.

We sincerely hope that the students were able to complete the labs with **MORE** questions about biological science than they had before entering the program, and that the curiosity stimulated by the High School Honors Program laboratory work will assist these students to actively continue their quest for knowledge throughout their college training.

# Red Blood Cell Transport

**Principal Investigator and LBL Research Scientist:** Robert Macey
Associate Faculty
Applied Science Division
Professor, Department of Physiology & Anatomy,
University of California, Berkeley

| **Students:** | | | | |
|---|---|---|---|---|
| | Eva Birnbaum | New Mexico | 16 yrs. | F |
| | Michelle Enger | Iowa | 17 yrs. | F |
| | Richard Lupia | Connecticut | 17 yrs. | M |
| | Niraj Patel | Michigan | 17 yrs. | M |

**Topics included:** Transport across cell membranes; different types of transport; regulation and feedback; energy requirements; hydration role of transport in nerve and in red blood cells; computer simulation and predictability.

Eva Birnbaum (New Mexico) and Tien Nguyen (Wisconsin) discuss lab techniques with Alex Quintanilha.

# Oxidative Stress

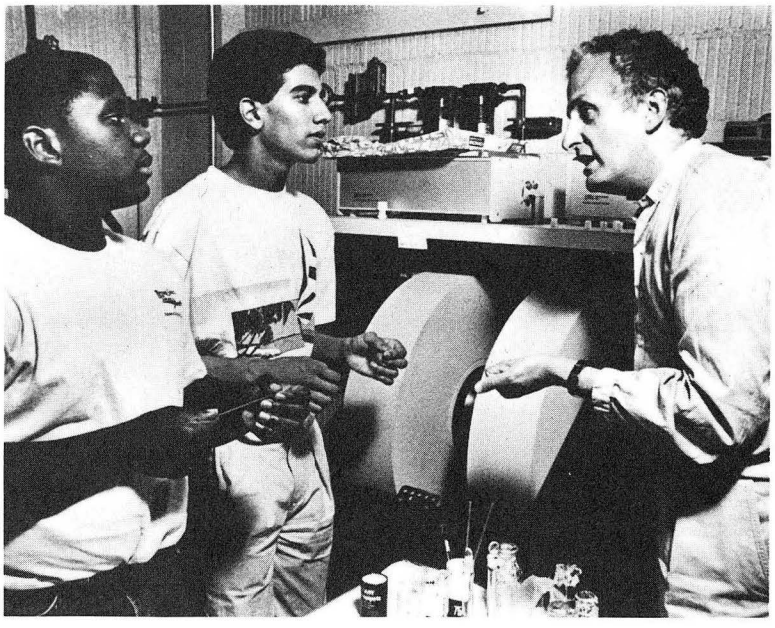
**Principal Investigators and LBL Research Scientists:**

Alexandre Quintanilha
Staff Scientist
Applied Science Division
Adjunct Professor, Department of Physiology,
University of California, Berkeley

Lester Packer, Professor,
Department of Physiology & Anatomy,
University of California, Berkeley

| **Students:** | | | |
|---|---|---|---|
| Jeff Ayer | Arizona | 18 yrs. | M |
| Kristan Boyd | South Dakota | 18 yrs. | F |
| Michael Drennan | Texas | 17 yrs. | M |
| Carol Gaudette | New Hampshire | 17 yrs. | F |
| Carl Jackson | Missouri | 17 yrs. | M |
| Tien Nguyen | Wisconsin | 17 yrs. | F |

**Topics included:** Free radicals and activated species of oxygen; generation in vivo and in vitro; methods of detection; biological defense mechanisms; repair; benefits and liabilities of oxygen toxicity to cells; physiological (and pathological) significance of oxidative stress to cells and tissues.



Carl Jackson (Missouri; left) and Niraj Patel (Michigan; center) discuss laboratory techniques with Alex Quintanilha (right).

# Radiobiology Modeling

**Principal Investigator and LBL Research Scientist:** Aloke Chatterjee
Senior Biophysicist
Biology & Medicine Division

| **Students:** | | | | |
|---|---|---|---|---|
| | Valerie Baker | Nebraska | 18 yrs. | F |
| | Bryan Blood | Massachusetts | 18 yrs. | M |
| | Renee Cooley | Washington, DC | 16 yrs. | F |
| | Boyd Saul | Wyoming | 18 yrs. | M |

**Topics included:** Applications of molecular modeling to assess induction of DNA damage by various types of irradiation; various irradiation facilities which are available at LBL and their use in research and clinical biomedicine.

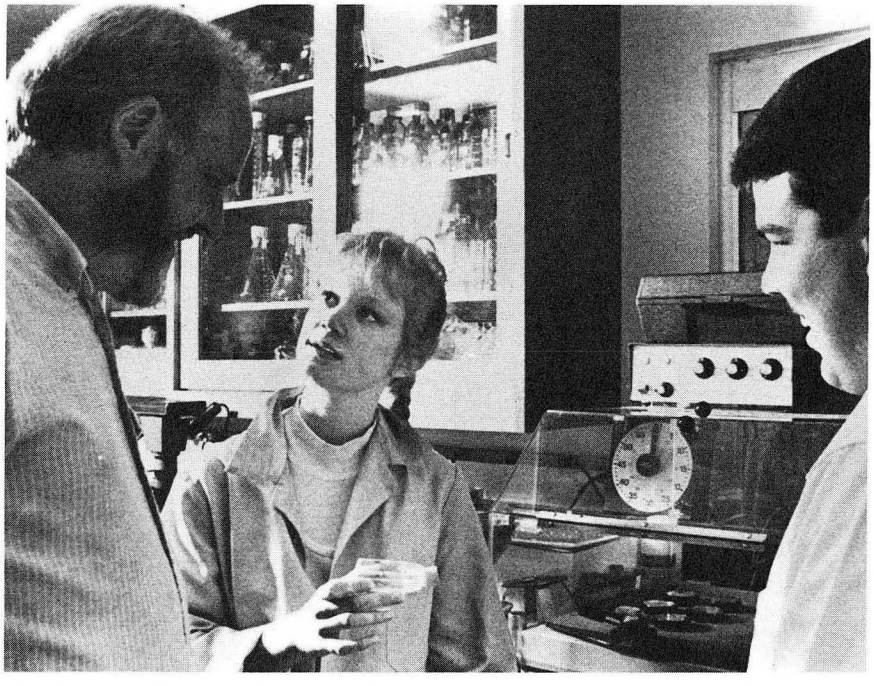
Renee Cooley (Washington, DC; left) and Valerie Baker (Nebraska; right) study electrophoresis techniques in the Radiobiology Modeling lab of A. Chatterjee.

# Cell Biology

**Principal Investigator and LBL Research Scientist:** Richard Schwarz
Staff Biochemist
Biology & Medicine Division

| **Students:** | | | | |
|---|---|---|---|---|
| | Jennifer Bragg | Maine | 16 yrs. | F |
| | Robert Kernodle | Indiana | 17 yrs. | M |
| | Craig Murders | Arkansas | 18 yrs. | M |
| | Theresa Simmonds | Pennsylvania | 17 yrs. | F |

**Topics included:** Application of cell biology at cellular and molecular level; preparation of primary fibroblasts techniques, basic tissue culture manipulation, detection of mRNA and gene products at the cellular level and RNA/DNA blotting techniques (Southern and Northern blots).



(Left to Right) Richard Schwarz, Theresa Simmonds (Pennsylvania) and Robert Kernodle (Indiana) discuss agarose cell samples collected for DNA research.

# Human DNA Sequencing

**Principal Investigator and LBL Research Scientist:** James Bartholomew,
Deputy Division Head
Biology & Medicine Division

| **Students:** | | | | |
|---|---|---|---|---|
| | Michael Aldridge | Tennessee | 17 yrs. | M |
| | Heather Heppler | Utah | 18 yrs. | F |
| | Julie Jangula | Louisiana | 17 yrs. | F |
| | Goodwin Liu | California | 16 yrs. | M |

**Topics included:** Replication of genes in human cells programmed during the S phase of the cell cycle; study of mechanisms that control the order of gene replication and copy number using the SV40 viral DNA replication in human cells as a model system.

Michael Aldridge (Tennessee) practices DNA-sequencing techniques.

(Left to right) Heather Heppler (Utah), Principal Investigator Jim Bartholomew, Goodwin Liu (California) and Julie Jangula (Louisiana) discuss DNA-sequencing techniques.

# Genetics of Photosynthesis

**Principal Investigator and LBL Research Scientist:** John Hearst
Associate Faculty
Chemical Biodynamics Division
Professor, Department of Chemistry,
University of California, Berkeley

| **Students:** | | | | |
|---|---|---|---|---|
| | Robert Greer | Vermont | 17 yrs. | M |
| | Albert Hsia | Maryland | 16 yrs. | M |
| | Eleanore Kim | Illinois | 14 yrs. | F |
| | Daron Scherr | North Dakota | 18 yrs. | M |
| | James White | West Virginia | 17 yrs. | M |
| | Leslie Widdison | Washington | 17 yrs. | F |

**Topics included:** Genes encoding the photosynthetic components of Rhodobacter capsulatus which are clustered in the genome; isolating and cloning to allow sequencing; computer analysis of the sequence to find sequences which overlap from clone to clone.


Albert Hsia (Maryland) and Marie Alberti (lab supervisor at LBL) learn how to identify gene sequences.

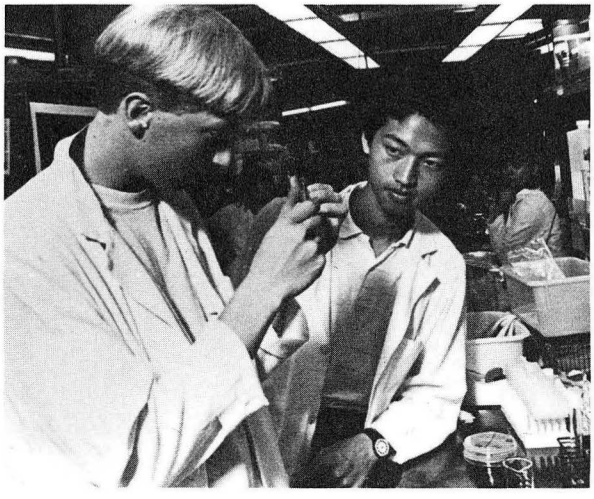
# Structure of DNA and Protein

**Principal Investigator and LBL Research Scientist:** Sung-Hou Kim
Senior Chemist
Chemical Biodynamics Division
Professor, Department of Chemistry,
University of California, Berkeley

| **Students:** | | | |
|---|---|---|---|
| Vance Bell | Idaho | 17 yrs. | M |
| Jason Degoes | Rhode Island | 17 yrs. | M |
| Sonya Johnson | Kentucky | 16 yrs. | F |
| Lewis Lee | Hawaii | 17 yrs. | M |
| Erika Manning | South Carolina | 16 yrs. | F |
| Claudia Santosa | New York | 18 yrs. | F |

**Topics included:** Cloning of DNA which codes for the catalytic RNA; isolation of RNA polymerase; isolation of catalytic RNA; purification of catalytic RNA.

Erika Manning (South Carolina; left) and Sonya Johnson (Kentucky; right) prepare lab samples for DNA analysis.



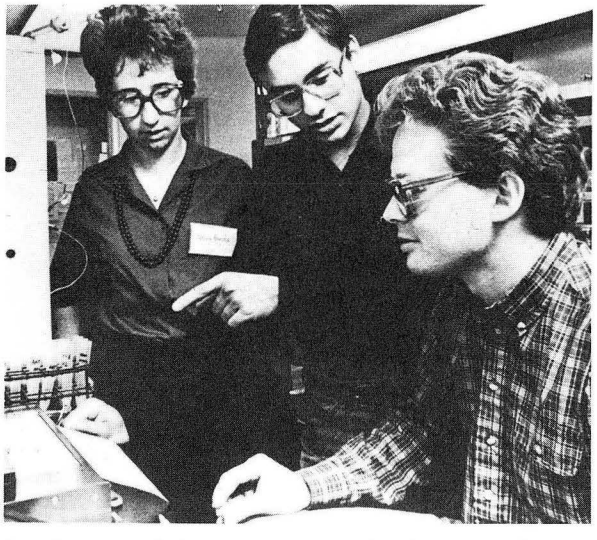
Vance Bell (Idaho; left) and Lewis Lee (Hawaii; right) work on laboratory techniques used to analyze DNA and protein.

# Biological Magnetic Resonance

**Principal Investigator and LBL Research Scientist:** David Wemmer,
Associate Faculty
Chemical Biodynamics Division
Assistant Professor,
Department of Chemistry,
University of California, Berkeley

| **Students:** | | | | |
|---|---|---|---|---|
| | Darcy Arriola | Oregon | 17 yrs. | F |
| | Jan Brzosko | New Jersey | 18 yrs. | M |
| | Laura Coltrane | Virginia | 16 yrs. | F |
| | Angel Guerra-Torres | Puerto Rico | 16 yrs. | M |
| | Lawrence Lee | North Carolina | 17 yrs. | M |
| | Penny Menhusen | Kansas | 18 yrs. | F |

**Topics included:** NMR Spectroscopy, demonstrations of the spectrometer, on-line computers for data analysis and structure calculations, usage of computer graphics for molecular modeling; chromatographic methods for purification of biomolecule samples for spectroscopy; detection methods for verifying purity.



(Left to right) Darcy Arriola (Oregon), Jan Brzosko (New Jersey) and LBL researcher Jeff Pelton use on-line computers to describe molecular models.

Penny Menhusen (Kansas) and Laura Coltrane (Virginia) work with biomolecule samples in the Wemmer lab.

# DNA Repair

**Principal Investigators and LBL Research Scientists:**

Priscilla Cooper,
Staff Biochemist
Biology & Medicine Division

Steven Leadon
Staff Biochemist
Biology & Medicine Division

| **Students:** | | | |
|---|---|---|---|
| Rajeev Dujari | Delaware | 17 yrs. | M |
| Kim Hawley | United Kingdom | 19 yrs. | F |
| Rebecca Kaplan | Canada | 17 yrs. | F |
| Julie Kittams | Alaska | 17 yrs. | F |
| Tracee Watkins | Mississippi | 17 yrs. | F |
| Kristie Willett | Ohio | 16 yrs. | F |

**Topics included:** Environmental agents which create damage in the genetic material of living organisms; approaches and techniques used to study DNA repair processes; measurement of mutagenesis and killing of bacteria; measurement of replication of DNA using incorporation of radioactive isotopes; isolation and purification of DNA.

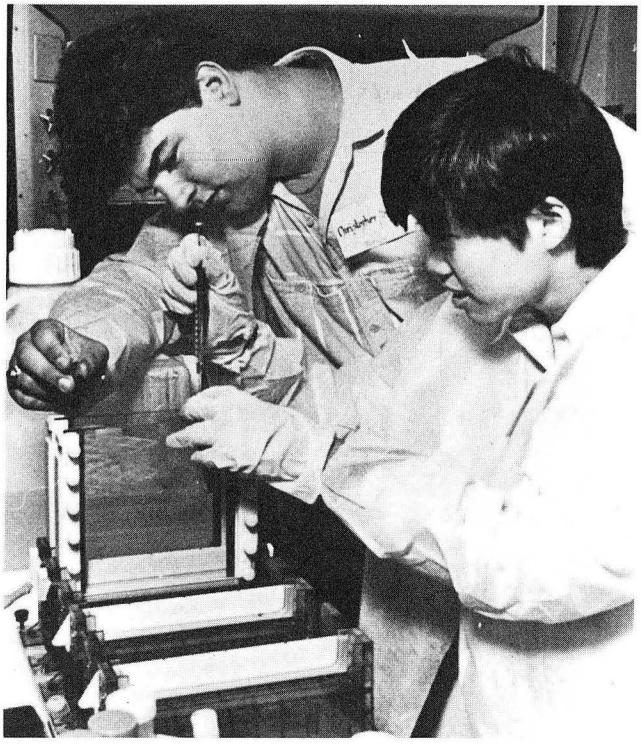
Julie Kittams (Alaska) and Kristie Willet (Ohio) prepare samples for ELISA experiments.

# Carcinogenesis

**Principal Investigator and LBL Research Scientist:** John Bartley
Deputy Division Head,
Biology & Medicine Division

| **Students:** | | | | |
|---|---|---|---|---|
| | Katherine Shiue | Nevada | 16 yrs. | F |
| | Christopher Smith | Florida | 18 yrs. | M |
| | Jeanine Williamson | Alabama | 17 yrs. | F |
| | Wayne Yu | Oklahoma | 16 yrs. | M |

**Topics included:** Utilization of human breast epithelial cells in culture to study the mechanisms of cancer development by chemical carcinogens at the cellular and micromolecular levels; isolation of products of carcinogen metabolism by high pressure liquid chromatography; use of nutrients (fatty acids) and metabolic inhibitors to establish metabolic pathways involved.



Christopher Smith (Florida) and Katherine Shiue (Nevada) prepare cell samples for study.

# Antibodies and Gene Expression

**Principal Investigator and LBL Research Scientist:** Gordon Parry
Staff Biochemist
Biology & Medicine Division

| **Students:** | | | | |
|---|---|---|---|---|
| | Cort Raithel | Montana | 17 yrs. | M |
| | Laurel Steele | Colorado | 17 yrs. | F |
| | Toru Iwasaki | Japan | 17 yrs. | M |
| | Stephen Walker | Georgia | 18 yrs. | M |
| | Heather Zwickey | Minnesota | 18 yrs. | F |

**Topics included:** How tissue specific characteristics of a cell are influenced by its micro-environment; how a cell's interaction with the basal material on which it sits, and its interaction with adjacent cells, can influence the nature and quantities of proteins that the cell makes; use of the following techniques: epithelial cell culture, monoclonal antibody production, gel electrophoresis, immunofluorescence microscopy, Western blotting procedures and cDNA methodologies.

(Left to right) Laurel Steele (Colorado), Toru Iwasaki (Japan), Heather Zwickey (Minnesota), Cort Raithel (Montana) and LBL researcher Karen Zettle observing the results of tests for gene expression.

# Students' Comments

## Radiobiology Modeling

I feel this is one of the most exhilarating experiences I have ever had. The entire two weeks have been overflowing with important and exciting data. The speakers were very in tune with our level of instruction, and they were as excited as we students were about the program. The labs and lectures have given me better insights to the world of scientific research and study.

My personal goal has always been to work in the general area that was covered by this program. It has helped me immensely as far as my background and future interests.

Our laboratory project (Radiation Biology) was under the direction of Dr. Aloke Chatterjee. Ernst Henle (graduate) and Sujit Chakravorti (undergraduate) aided us in our investigation to study the effects of ionizing radiation on DNA.

Our goal was to learn lab procedures and interpret the results. From the results we want to learn how radiation interacts and affects the DNA.

DNA (deoxyribonucleic acid) is affected by radiation in two ways — directly and indirectly. The direct effect is a result of depositing energy on the DNA strands, creating a break. The indirect effect is a result of splitting the water molecules into radicals (H, OH, and $e_{aq}$), which in turn attack the DNA strands.

The DNA is left in three forms from these attacks. Form I is small, compact, unbroken DNA; Form II is loosely coiled DNA with a single strand break; and Form III is linear DNA with a double strand break. By analysis of the DNA a scientist can get an accurate idea of the damage inflicted by the radiation.

The simplest method for separating the three forms of DNA for analysis is by electrophoresis. Electrophoresis is a process which uses electricity and the polarity of DNA.

A gel block is made of agarose and Tris Borate EDTA. The agarose is poured into a square container which has a comb set in it. The comb creates wells or pockets for the DNA.

The agarose gel is then placed in an electrophoresis tub containing a pH 7.5 Tris Borate EDTA buffer. The purpose of the Tris is to scavenge the radical OH species in the water so cellular conditions can be better simulated. A pH 7.5 is due to the fact that alkaline water will break the hydrogen bonds in the DNA strand.

The DNA is pipetted into the wells created by the combs in 10 μl amounts. The DNA is concentrated to one microgram per microliter. After this tedious task, the electricity is run through the solution in the tub between the two platinum wires. The current is run at 200 milliAmps and 100 volts for three hours. The gel block is then removed from the tub and stained with Ethidium Bromide. A photograph is taken using ultra-violet light and polaroid type 55 film, which allows a person to take a positive and negative simultaneously.

The photograph contains bands of DNA in three horizontal lines. The first horizontal line is Form II, the second line is Form III, and Form I is farthest from the wells, showing that it is the least damaged.

The negative is then scanned by the laser densitometer. The densitometer measures quality and quantity. Quantity is measured by the amount of light passing through the bands of DNA. Quality is measured by the placement of the bands. With the information that the densitometer qualifies and quantifies, scientists can realize the damage to the DNA.

The laser of the densitometer reads across, starting with the first well (zero dose), which is a control and has not been irradiated. This shows two things: where Form I will migrate to and the purity of the unirradiated DNA.

The next well contains DNA that has been radiated with (x) doses. This amount (x) depends on the desired results. The top two bands will now begin to form, and the survival rate of the DNA can now be plotted by the computer.

This type of research deals with the most basic level of DNA. In order to find the effects of radiation on humans, the human DNA must be used instead of SV40 DNA. As the research continues, I would want to try to include, step by step, each functioning cell part, moving up to an entire system.

Valerie Baker

The DOE-LBL Life Sciences High School Honors Program is an excellent rewarding program that enabled top science-oriented students to gather, interact and discuss many scientific topics. My overall experience cannot be expressed completely in words. These past two weeks will always remain as a turning point for my overall view of science and all of its possible aspects.

Every day at the mind-boggling lectures, speakers, both lab researchers and renowned scientists, warned us about all of the possible carcinogens that we eat. At one point in my life, I wanted to stop the world and find an antidote or cure to one of the many incurable diseases that is killing our population. Now, I realize that science research cannot be accomplished at a fast pace, but may take anywhere from five to twenty-five years.

The level of instruction was adaptable and not well above our heads. The program could have been lengthened to anywhere from four to eight weeks. The lecture/lab schedule could be rotated, but due to the lecture scheduling that may not be possible. Lab hours could be lengthened to maybe six hours a day because not very much can be accomplished in four hours. In order to reduce the budget, a maximum of five dollars for lunch should be mandatory and the elimination of the maids in the dorm.

Some questions that I asked - Is there any difference between the maturity mechanisms that cause or prevent natural plant growth? Can animal laboratory results be compared to humans? Will AIDS ever have a permanent cure or vaccine? If so, will only AIDS carriers or victims need it?

In retrospect to certain variables, plant research cannot be totally isolated. From what I interpreted from the lectures, many years of research have not told us the answers to many of these questions concerning plant growth. I personally do not think laboratory animal results should be diagnosed and compared to humans. AIDS, of course, may destroy the entire population or at least infect all persons healthy, homosexual, or heterosexual.

Electrophoresis is the transport of charged macromolecules in response to an electrical field, often used to separate mixtures of ions. DNA has a negative charge. DNA exists in three forms - Form I, II, III; the first - undamaged; the second - relaxed; and third - linear. The direct effect is the damage done to DNA strands when energy is deposited directly on it. The indirect effect is energy deposited in a medium of molecules which can damage the DNA, such as an OH radical. Dr. Aloke Chatterjee discussed the difference between the direct and indirect effect and all of its possible effects of DNA. Mr. Ernst Henle and Mr. Sujit Chakravorti assisted the group throughout the entire experiment. The purpose of the experiment was to identify any possible DNA damage done by radiation.

One gram of agarose powder was added to 125 ml of TBE and heated to a vigorous boil. The gel was placed in a frame and left to cool. The gel was placed in an electrophoresis tub. 10 ul of irradiated DNA was pipetted into wells of gel. The gel was then electrophoresed at 100 volts with about 200 mAmps for 3 hours. The gel was then stained with Ethidium Bromide. A solution of $MgSO_4$ was placed over the gels. Photographs were taken with a Polaroid camera while the gel was over a ultraviolet source. The negatives of the photographs were scanned with the densitometer.

The DNA was placed in the wells of the gel. The wells were placed opposite the positive side because DNA has a negative charge and opposites attract. With the Ethidium Bromide stain and ultraviolet rays, we were able to observe the length of migration from the original position of the irradiated DNA. Form I moves the farthest, then Form II and Form III,

respectively. The densitometer scans the bands of DNA by measuring the amount of light that passes through. A computer hooked up to the densitometer analyzes the amount of light which passes through all three bands of separated DNA. The different absorbances are then plotted *vs.* length of the track, which produces peaks. The three different peaks represent the three different forms. These peaks are then integrated to get relative ratios of the forms.

In my personal opinion, genetic lab research may not be accurate enough to analyze all aspects of the effects of radiation on DNA. As far as potential interest, I have no permanent plans about science-related lab research for the near future. I plan to attend college, but right now my major is undecided. I enjoy science as a hobby, but I am open to all aspects about my long-term career.

Renee Cooley

*General Comments:* The opportunity to work in a national laboratory was both rewarding and beneficial. Working with a laboratory team headed by Dr. Aloke Chatterjee, I learned scientific theories that were new to me, and allowed me to learn how to test some of these theories in the laboratory.

My views of science have changed in that I now realize that in order to conduct research in the medical field, one needs an extensive background in all the sciences, and probably a Ph.D. in Biochemistry.

Dr. Chatterjee, Bobby and Ernst have been eager to teach us the theory behind their research as well as many aspects of conducting this research. I have learned many new hands on techniques which will probably be useful to me when I go to college this fall. I would not have learned these techniques without this program. Interaction with students in the lab has been interesting. Interaction with everyone as a whole has been great. It seems that we have become a great big family with the counselors as parents. It will be hard to say goodbye to such a nice group of brilliant people.

I have been to two other major science related activities such as this one, and this one was by far the best. The level of instruction in both the lectures and the lab was perfect. It was not too complex, and they were not teaching us something we already knew.

I wish that the program lasted all summer, or for at least one month. In two weeks, although I know much more about science and laboratory research than when I came here, we have just scratched the surface of what we could have learned if we had more time.

The only two suggestions I have would be to lengthen the program as a whole as well as lengthen the lab periods. For instance, to have 8 hour labs every other day instead of 4 hours of lab time every day. This would provide more continuity during the labs.

*Introduction:* The overall purpose of Dr. Chatterjee's group is to study the effects of radiation on DNA that has been removed from living cells. The theory behind this is that the most important part of the cell, and the part that controls the cell's replication, is the DNA. Therefore, it is easier to study the effects of radiation on just DNA rather than studying the effects of radiation on the entire cell.

The purpose of *our* investigation was to study the effects of radiation on DNA. The radiation can deposit its energy directly on the DNA and cause a strand break. This is called the direct effect. The radiation can also form radicals in the water the DNA is in, which react with the DNA by breaking chemical bonds and causing strand breaks. The radical that causes the most damage is the OH radical.

After DNA is irradiated, you end up with three forms of DNA instead of just one form. Form I is not damaged by exposure to the radiation and is tightly wound. Form II is DNA with a single strand break; it is circular and loosely wound. Form III is linear and has suffered a double strand break. In our experiment, we tested for the percentage of each form of DNA using electrophoresis and a laser densitometer.

*Procedure:* I prepared an agarose gel with 20 wells in it. Then I filled the wells with 10 microliters each of DNA which were irradiated at different levels (different doses). Then Ernst stained the gel with Ethidium Bromide. I then destained the gel with magnesium sulfate. I did this by submerging the gel in $MgSO_4$ and rinsing the gel with deionized $H_2O$. After that Boyd and I took the gel upstairs and photographed it using ultraviolet light. After photographing the gel, we took the negative and ran it through the densitometer to determine, through interaction of the peaks produced by the densitometer, the percentage of each form (I, II, or III) of DNA we had. This in turn tells us the amount of damage for different doses of radiation on the DNA, and what forms of DNA different doses cause.

*Extraneous variables:* The biggest extraneous variable is that the Ethidium Bromide is absorbed at different rates by the different forms of DNA (Forms I, II, and III). Therefore, the darkness of the bands may indicate more DNA in a certain bands than may be present.

*Conclusion:* Although we do not have time to theoretically process our data, I did learn that it takes much longer than 2 weeks to learn how to conduct an experiment, and even longer than that to understand the theory behind it.

Bryan Blood

I believe that the LBL program is a fabulous opportunity for high school students and graduates. The program offers challenges suitable for our level of education without memorizing various concepts. They let

us learn ideas and concepts so that we can continue learning about them long after we have gone home.

The program is only half study. The rest of our time is filled with trips, movies, and laughter. Our trips take us to beaches, bridges, and parks. We have gone to see the Rocky Horror Show as a group, but we have also rented movies on our own and watched them in the dorms. After we get back from our labs, we can sleep, play basketball, go swimming, sleep, play badminton, play volleyball, or sleep. Having the top kids in the nation get together is a great experience.

When I arrived at the program, I was amazed how far DNA research had progressed. I was also impressed by how much we now realize we do not know. I know I want to pursue an education in science. I feel that the other students feel the same way I do: that this is a fantastic program. We feel comfortable around each other and that it is alright to make a mistake. Several of us have commented on how wonderful it feels to have a real conversation with someone. The counselors are excellent. They give a lot of freedom and let us take responsibility for ourselves. They make sure we get where we are going at the right time without making it seem like they are watching us every second. The lab instructors were adept at getting the point across. The instructors and assistants were able to speed up or slow down so that we were with them almost all the time and were able to get an in-depth understanding of our subject.

Several of the lecturers were not aware of how quickly the main body of the students is capable of picking up concepts or of the background in science that the students had. A few times we were ahead of lecturer's words and only learned a few details. The lecturers were for the most part interesting. Three of the lectures ranked as excellent; three others were tedious at best. Of course, this is only my opinion.

It is a shame that the program lasts only two weeks. I learned as much during these past two weeks than in my entire final semester of high school. A more lengthy program would be better.

The LBL program cannot be improved very much. Lengthening the program to at least a month is my very first suggestion. Although I was honored by the choice of lecturers, it is my suggestion that the lecturers be better informed about their audience. Also, the activities that were arranged for us were great, but a few more open nights would be appreciated, perhaps in a longer program this would be possible.

One of the questions raised in my mind is just how much of human DNA is critically important to the survival of the cell. During the program and especially the lab, I found out that while much damage is done to cell DNA, very little of it is responsible for cell death. To investigate this, it would be necessary to discover the function of every gene on every strand of DNA in the nucleus. Considering the fact that it is very difficult to discover the function of a gene, and that there are approximately

$6 \times 10^9$ base pairs on the human genome, one must realize how extremely huge this task is. Also, many gene's functions depend on the functioning of other genes. Simply isolating, removing, or mutating a series of base pairs will not suffice. It is unlikely that DNA will ever be totally understood.

I have learned much more than can be summed up in a paragraph. In the lab, I learned many very important methods of studying DNA. I have also learned much about radiation and its effect on the cell and the mechanisms of radiation damage. The lab taught me too many specific things to mention. The lectures also taught me much. New insights about cell aging, cancer, differentiation, and the negative effects of oxygen were studied.

In the future, I might explore the questions about cancer or DNA. The LBL program has exposed me to the cutting edge of bio-science and has made me interested in what I had previously thought was uninteresting.

Boyd Saul

## Cell Biology

Dear Mom and Dad,

Here we are with one day left in the Life Sciences Honors Program at U.C. Berkeley, and we thought we'd write and tell you how things have gone.

They couldn't have picked a better location for this program! We're staying at the Clark Kerr Campus in Building 3. The rooms we're staying in were meant to house three occupants, but they've only put two of us in each one. It feels like home with the extra space to move around in. Unlike ordinary school food, the meals here have been prepared with elegance, and there's something to satisfy every taste. They have devised an ingenious system for meals. Each student gets a meal ticket, which he must show in order to enter the dining room. Other than a few people misplacing their cards, it worked out really well. Breakfast and dinner are served at Clark Kerr, while lunch is prepared at a cafeteria on campus.

Every morning after breakfast we take a chartered shuttle bus to the lecture hall, where two speakers present their most recent research. Afterwards, they are more than willing to answer any questions we have. Some of the topics we've discussed have been fantastic, and all of the lecturers are world-renowned researchers. We just wish that there had been more female speakers. Our favorite was Dr. Mina Bissell, one of the two women who spoke. Although the lectures were fascinating, we were overwhelmed with the quantity of information we absorbed in each three hour period. We think that one lecture in the morning and one in the

afternoon, separated by lunch and labs, would be a much better schedule.

Another thing that has kept us busy is all the activities that they had planned. We've been to an Oakland A's baseball game, the Exploratorium, the Lawrence Hall of Science, Golden Gate Park, and Point Reyes National Seashore. In the evenings we've spent our free time playing volleyball, basketball, tennis, pool, cards, and other group games. They have also reserved the pool for us on several occasions.

Our favorite part of the trip has been the labs. We worked on cell biology with Dr. Richard Schwarz and Karen Smith, a graduate student. We've also had help from Birgitta Kullgren, a lab technician for 35 years, and Dr. Mina Bissell, who took two hours out of her hectic schedule to talk to us about a future in science. We think we've had the best lab out of all the groups. We have irradiated mice using the bevalac, isolated tendon cultures from ten-day-old chick embryos, cut and pasted DNA and run several agarous gels to separate the different strands, watched technicians extract bone marrow and spleen cells from a freshly killed mouse specimen, and observed other graduate students and post-docs at work. We just wish that every student in this year's program could have enjoyed his lab as much as we did ours!

The most interesting asset of the program has been the caliber of people gathered here at LBL. The administrators have done a fantastic job organizing, and things have run quite smoothly. The choice of counselors was superb. They're easy to get along with, and they really seem to care. They've basically given us the reins as long as we're reasonable. Each state was well-represented. Although we all have varying tastes, we've gotten along extremely well to have known each other for two weeks. We are truly going to miss each other when we leave.

All together, this year's program has been highly successful. The people we've met and the fun we've had have made this an experience we'll always remember.

Jennifer Bragg
Robert Kernodle
Craig Murders

## Human DNA Sequencing

Having completed the first Lawrence Berkeley Laboratory High School Honors Program, we feel truly privileged to have been involved in such an experience. From the informative lectures given by researchers at the top of their respective fields, we developed a broader scope of scientific interests and were updated on recent findings in these fields. Along with

the lectures, the lab work caused us to question what was presented in terms of understanding the information as well as suggesting the possibilities for the future that the data implies. We learned that science requires patience, time, and dedication. (An electrophoretic gel film was never prepared in one day!!) Also, research is not as glorified and simplified as many believe; through many long hours and complicated processes a simple idea is arrived at, unlike the misconception of ideas being like sparks. While research is educational and fulfilling, often we must be satisfied with facing one obstacle at a time instead of attempting to understand everything instantaneously.

Through this program, we have learned that textbook science is transient. In order to pursue science, we must keep informed through journals, seminars, and other opportunities for sharing information, since science is an on-going process, changing each day. Especially through the speakers, we have realized the wide array of possibilities for research, and this has inspired us to pursue our individual interests in science while staying in tune with scientific developments in general. The *amount* of research presently being done is surprising in itself.

Beyond the general feel for science we gained, we learned many specifics. The level of instruction was advanced enough to challenge us yet close enough to our backgrounds so as to not discourage us. The high level of teaching caused us to ask questions and *think*.

Because so much information was incorporated into the program, it is our suggestion that the same amount of material be presented over a long span of time, as concentration and attention have their limits.

Besides the science involved, we have made friends with people that we will stay in touch with for many years to come because of our common bond of science and because of the diversity of interests beyond science. We learned about personal relationships through tolerance, acceptance, and humility when in a group so elite as this one. At home most of us were perhaps the big girl/guy on campus; however, here is the aggregation of these special individuals with no one being greater than another. Because of this, we have come to respect the qualities and achievements unique to each person. At the program, we experienced no inhibitions about expressing ourselves freely, openly, honestly.

In evaluating the program, we offer some suggestions for its improvement. Administratively, a more precise outline and description of activities outside of lectures and labs (i.e., evenings and the weekend) should be provided before arrival. A more specific itemization of our options during free time (Rocky Horror, Telegraph, volleyball, basketball) would have helped us to better prepare for the trip in relation to clothes and money specifically. (Also, advise all future LBL students to bring a loud alarm clock!) A source of minor confusion was the morning bus

schedule; if possible, we suggest requesting another bus at 8:10 instead of a 7:50 shuttle.

Inside the lab the focus should be to provide as much opportunity for lab work as possible, since time is limited. Thus we propose that each lab mail out its respective background material to its participants prior to the program to allow more time in the lab and less time in lecture. Readings we can do at home, but lab work we cannot. To enhance communication among students along scientific lines, we suggest a 30-minute feedback period for students and counselors after dinner just to share daily experiences and offer improvements as the days progress.

Already we have emphasized the stimulating effect of our experiences here. Many scientific questions have been raised in our minds. We have begun to wonder, for instance, what environmental factors will affect organisms now and in the future (i.e., radioactivity). Will these factors be helpful or harmful? How should we utilize resources and technology to monitor and shape the environment to suit our best interests (i.e., energy supply, nuclear energy, Calvin's oil plants)? We have also run into many unanswered questions regarding diseases. What technology can we use to diagnose and treat malignancies before their propagation? How do we combat disease within the affected tissue, and even more importantly, how do we fight disease within human DNA, a topic that has unlimited implications? When the human genome suffers mutation, either from an error in coding or viral transfection or other environmental factors, how do we inhibit the expression of the disease? Perhaps it is possible to build genes to form needed materials (i.e., proteins, enzymes) that will destroy diseased cells or disease transmitters. In the field of pharmaceuticals, how can technology create a finished product that is both potent and economical? Through the lectures and lab experience, we have realized that these avenues of study with infinite possibilities for mankind are to be addressed by our generation. In order to solve these problems, we must take an active part in scientific research, stay updated and informed about current work, publish our work so that it may be shared with others, and always maintain a firm working background knowledge of our subject matter through interaction with other scientists and through travel and exposure.

In the lab, we have learned several techniques and concepts such as gel electrophoresis, DNA sequencing, cell transfer, DNA content measurement in a flow cytometer, measuring radioactive particles in a scintillating counter, building radioactive probes, hybridization techniques, maintaining sterility, and general lab procedure and safety. Lectures in labs have taught us about tissue cultures and their life cycles and interactions with viral particles, the universal nature of the DNA code, the inter-relatedness of all the factors of an experiment, the flexible use of genetic material (i.e., cloning, inserting), the importance of Simian Virus 40 in relation to the human genome, and the experimentation on a non-visible level (i.e.,

molecular biology). Through our particular lab, our interests in biology beyond the cellular level were sparked, and we learned the thought processes involved in research, mainly the simplification and understanding of a problem before seeking its solution.

In conclusion, the LBL Honors Program was enriching and enlightening and not only sparked our interest in scientific research but also provided us with experiences we will carry with us for the rest of our lives.

Michael Aldridge
Heather Heppler
Julie Jangula
Goodwin Liu

## Genetics of Photosynthesis

Upon the completion of our two week experience at Lawrence Berkeley Laboratory, we would like to take this opportunity to reflect upon the DOE-LBL Life Sciences High School Honors Program. This program has been an enriching and an encouraging experience for those of us who had chosen the life sciences as a field of study, and for those unsure of their careers the two weeks provided them with an opportunity to explore the life sciences first-hand.

The program has enabled us to actually touch and feel science instead of merely intaking it ocularly from a decade-old text. Our perspectives have been broadened as we have gained knowledge in sundry fields such as recombinant DNA, biosynthesis, and bacteriology. Given, we have delved minimally into these areas, but here we arrive at the purpose of the Life Sciences Program: exposure. Under the guidance of Marie Alberti and Dr. John Hearst, we searched the Rhodopseudomonas bacteria genome for the carotenoid A gene. This gene codes for the enzyme which catalyzes the oxidation of sphaeroidene into sphaeroidenone. In this manner, potentially toxic oxygen is bound and thus unable to damage the cell membrane and other cell tissues. The search involved the sequencing of a four-kilobase-long DNA chain; homology amongst protein sequences; and ribosomal binding site comparisons. Our results were surprisingly successful: it is quite possible that we have identified the carotenoid A gene, which could be 591 amino acids in length.

Apart from our work with photosynthetic bacteria, we also observed the ongoing research endeavors of other members of the Hearst group. And so we watched agape as graduate students and senior members inoculated bacteria, conducted the entire electrophoresis process, and synthesized DNA in a contraption much like a laundry machine. The enthusiasm of these scientists was quickly transferred to us, as were the close ties between members of the Hearst group. We learned that sci-

ence can provide all the necessary rewards: excitement, change, societal significance, and even friendship (well, almost all).

With the High School Honors Program at Berkeley a newborn, we would like to offer a few suggestions:

1. The lectures should be designed for the general knowledge level of an upperclass high school student. While a majority of the lectures were appropriately presented, some surpassed our collective comprehension level.
2. The daily agenda was well planned and enjoyable, though a more free daylight hours would segment the continuum of LBL life considerably. The group excursions were, for lack of a more descriptive adjective, great (though we are all now surfeit with hands-on science).
3. Appropriately lastly, we passionately urge you, for the sake of future scientific generations, that the program be lengthened. To end after two weeks is to cut off just-developed friendships and the honing-in process of research. The only disadvantage of lengthening of the program would be the logarithmically escalating lunch expense. In other words, make it longer!

We thank you for this unique opportunity.

Robert Greer
Albert Hsia
Eleanore Kim
Daron Scherr
James White
Leslie Widdison

## Structure of DNA and Protein

My participation in the 1987 DOE LBL Life Science High School Honors Program was a proverbial once-in-a-lifetime experience. As a high school student I was treated with enormous respect and patience by post-docs, professors, and Nobel laureates alike. People who usually found their time extremely scarce and valuable would postpone other things in order to lecture, explain, or idly chat about things terribly complex, or happily everyday. Very personal, very considerate, very effective, and a very pleasant change.

The other delegates I found myself with were not the stereotypical group of thoughtless number crunchers that too often pervades an average person's conception of "a scientifically minded youth." These people were for the most part mature, outgoing, and extremely intelligent. It was quite a strong combination to find in one person; and of these, Berkeley had many.

I can offer few recommendations unfortunately. I felt as if the length of the program was a trifle short—fourteen days. It was ample, but eigh-

teen or nineteen days would have been more appropriate and timely (in my opinion). The accommodations were more than well taken, as was the idea of graduate school chaperons. The maids could have washed and pressed my laundry, but I don't believe that was in the budget (I for one usually end up doing my own at home). Overall it is difficult to condemn a good thing.

In my area it is hard to find quality laboratories or research facilities to look at, let alone work in. Berkeley bordered on being unbelievable in my eyes for that reason (call it intellectual deprivation). I felt challenged, though not overwhelmed, being in that atmosphere for the first time. It was very up close and personal, not competitive and closed like some places I am familiar with. Berkeley has an aire which in itself is something special. It holds true with its reputation as a very liberal and open-minded place. For those who thrive on variety, it is practically paradise. I would recommend this program to anyone remotely qualified. Fantastic is a soft word to describe the excellent job done by those involved.

Vance E. Bell, Jr.

# Biological Magnetic Resonance

## Introduction

Thermophilic cyanobacteria contain several parts in their photosynthetic system. Two specific protein complexes that are of interest are the phycobilisomes and the photosystem II (PSII), because they play major roles in the cyanobacterium's interaction with light. The phycobilisomes are the light-harvesting antennae that gather light and direct the energy to the PSII, where the photosynthetic reactions take place. Here in the cell membrane, the PSII complex produces oxygen from water by using the energy from the light. The exact inner processes of this complex are unknown, but the members are chlorophyll for the light-energy absorption, a manganese complex that performs the water-to-oxygen reaction, and several other molecules that absorb the extra electrons and protons that are given off. The functions of these two complexes can be studied more closely by isolating them from the cell membrane and then examining each individually.

The cyanobacteria were grown from an original culture transferred to a heated 50-liter growth-medium solution, where they were furnished with the needed nutrients and light. The growth was monitored daily with measurements from a hemocytometer, fluorimeter, and spectrophotometer, and the expected exponential growth rate was found from the cell counts. After three days, the cyanobacteria were harvested and repeatedly centrifuged into concentrated pellets. These pellets were then re-

suspended and put through a French press to break up the cell membranes. Then the membrane particles were isolated for the preps. The phycobilisome preparation used a sucrose-density gradient to separate the phycobilisomes from the mixture, and the purity was analyzed with an electrophoresis gel and absorption scans. The PSII preparation was made with further centrifugation and re-suspension. A comparison of the oxygen evolution to the chlorophyll content was then established using an oxygen-evolution electrode and absorption scans. From these measurements, the rate of oxygen production from 50 liters of cells was determined to be 250 milliliters per hour.

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I found it extremely difficult to write down the experiences I had at the LBL-DOE Honors Program. It is a unique program in that I had a great time in such a variety of ways!

A few of the morning lectures blew right over my head, and one was a little too slow, but over all, the lectures were extremely informative and inspiring. The choice of speakers was excellent in quality and variety. I learned an extraordinary amount of information from the lectures, but the laboratory research was even better. I had never been in a research lab before, let alone used the equipment. It wasn't long, however, before I was using several state-of-the-art instruments by myself, along with many new lab techniques. My lab instructors were fun and relaxed, and they made sure we understood the processes before we actually did the work. This friendly atmosphere was perfect for learning new skills.

The social interaction with students of similar education goals and backgrounds was another advantage of this program. As friends, we involved ourselves in many controversial discussions, but the right to one's own opinion was strongly encouraged. We also spent much time unwinding together in various ways (swimming, volleyball, badminton, shopping, singing, eating, etc.)

I feel this program is a huge success. I was inspired, motivated, and taught new things every day of the seminar. I have only a few suggestions for next year's program:

1. Leave a couple of afternoons or mornings free to relax or shop. The only time we had to do this was late at night.
2. Plan a real sight-seeing tour of San Francisco instead of only science exhibits. (I would love to ride a trolley car!)
3. Recommend that the students bring more money ($20-$30 is not practical) and warmer clothes.

Penny Menhusen

My experience in the Honors Program has been unique. Even after attending a residential high school for students supposedly gifted in science and math, I have learned much about both science and people. All the students were definitely good in science, but we also represented a great diversity in our other interests. Most everyone had something to do either for fun or for showing off. I remember all the vicious volleyball games, the pool games with all the hustlers, the fights over what "good" music really was, and all the real conversations with friends. I met a lot of talented people who were not only "life science honor students" but good friends who were cheerful and fun.

I also learned much in the lab. Even though I have had prior research experience, I still learned a few more basic lab techniques, and practice of known operations was always helpful. I probably learned the most about the various instruments that were needed for measurements and about cyanobacteria in general. The lab atmosphere was also really good for learning. Everyone was friendly and informal, and I felt free to ask any questions. I'm really glad that we were allowed to perform much of the experimental procedures. Not only was it more interesting, but I learn better with actual work and practice. Our instructors also told us the principles behind our research so that we obtained more of a "big picture" and weren't just mindlessly following instructions.

This was a very good start for this program. All the counselors and administration were very enthusiastic throughout the two weeks, and they were very understanding. The lectures were very interesting, and my lab experience was very good. The social events were all pretty fun, even though we didn't spend much time in San Francisco. My suggestions for improvement would be to lighten up on the scheduling. So many things were planned everyday that it became hectic. I also think that too many lectures were planned, and maybe alternating between one and two lectures a day would be better. An overall solution would be to make the program just one week longer to lighten up each day's schedule. In this way, the students could also have some more free time for walking around Berkeley or just relaxing. I'm very glad that I had this chance, and I wish continued success for this program.

Lawrence Lee

The Department of Energy Life Sciences Honors Program provided me with an opportunity to explore new areas of scientific research and to gain knowledge and understanding of various laboratory techniques. Informative lectures and hands-on lab work provided the backdrop for two weeks of educational growth in the life science field.

For the most part, the instruction I received was very thorough and informative but not overwhelming. Surprisingly enough what I found to

be overwhelming were the debates and discussions between students (a.k.a. friends). I had never before been in the company of so many bright people at any one time. Everyone had so much to offer in the way of knowledge and ideas. My only wish was that the program could have been longer.

From my experiences, I have gained a better understanding of laboratory experimentation and the type of people who make it their living. Now, it is up to me to decide if I have what it takes to be that type of person.

Laura Coltrane

The unique and amazing opportunity to study and explore at Lawrence Berkeley Laboratory has been given to us. We have found it extremely educational. In this paper, we will first detail what we have learned in our lab, then comment on our overall view of the program.

The Wemmer laboratory, consisting of several graduate students and post-doctoral researchers, has proved very hospitable. They have put up with many tedious questions and have understood mistakes. From the beginning they have made us welcome. The Wemmer (NMR) laboratory consists of much expensive and intricate equipment. To run this equipment requires a thorough understanding of chemistry and physics. Thus we were not able to operate a lot, but gained a background understanding of how things work.

The first day we worked with Debbie and got an overview of the laboratory. She showed us the protein synthesizer and the DNA synthesizer. Then she explained to us her work involving the bonding energies between DNA bases. It has been shown that the amount of energy required to break apart the adenine-thymine bond is less than to break apart the cytosine-guanine bond. She used an intricate calorimeter to see how much energy it takes to break apart a synthesized strand of DNA.

Next we worked with Jeff. He showed us how high-performance liquid chromatography works. A synthesized strand of DNA (CGCGAATTCGCG) is run through a C18 filled column. All correctly synthesized DNA sticks by their DMT (dimethyloxytrityl) groups' hydrophobidity. By observing a light spectrograph set to a specific wavelength we could see when a chemical came off. We collected several fractions and discovered the DNA was incorrectly synthesized, so Jeff had to start over. His research involves the binding of a drug, distamycin, to DNA, causing many problems.

Beth showed us how to graph two-dimensional NMR spectra. It was very difficult, but we had fun. After much trial and error we learned some

of what was going on with the DNA interactions between protons of different bases. Beth also gave us some computer experience with NMR spectra.

Rick gave us a general understanding of the basic principles behind NMR. He explained how the interaction between two magnetic fields can give information about the position of different protons in the sample. He also gave us tours of the x-ray crytallography and laser labs.

Milton let us do some real wet chemistry. We mixed and poured gels and then ran electrophoresis on them. We were attempting to separate $\alpha$-cobratoxin from the sample. Milton is researching the effects of this toxin upon neuroreceptors. This includes proton interactions, structure, and physiological effects.

Joe let us look around the NMR machine and at some samples. His research involves a honey bee neurotoxin.

The Department of Energy has put on a good program. Our housing was comfortable, and the food was tasty. The facilities at Clark Kerr were suited to our needs, and we found them very comfortable. The staff of Clark Kerr was very kind and helpful in every way.

LBL provided excellent transportation to lectures and entertainment trips. Social events provided were a relaxing break. Meeting and talking with the other people was very interesting.

For next year we would like to suggest more lab tours for students. We saw only three labs, and the one we work in, and feel it would be beneficial to see more. We also would suggest a more independent lab program so as to provide students more work on their own. The food also may have been too extravagant. We could have survived on less.

Overall we found this program very educational and stimulating. We would recommend its continuation and commend Lawrence Berkeley Laboratory for its hospitality.

Darcy Arriola
Jan Brzosko
Angel Guerra-Torres

## DNA Repair

We feel that the High School Honors Program at Lawrence Berkeley was an exciting and challenging experience which we found to be very worthwhile.

This program has changed our views on science in many ways. We were surprised by the depth and diversity of the research. Not only did

we learn that the life sciences are highly interdisciplinary, but are related to other fields such as business and public policy. This experience has caused our interest in science to grow.

Meeting and working with the other students was one of the most important parts of the program. Sharing ideas with others with similar interests was very encouraging. It was stimulating to exchange views with students who had widely differing opinions on a broad spectrum of issues.

The scientists who worked with us were very helpful and patient. We were considered important enough to take the time to work with. There was never any condescension, and their enthusiasm was contagious.

Despite being at the frontier of their science, our instructors were able to channel the overwhelming flood of knowledge to all of us, even though we had varied experience.

We felt that the program should have been longer. Without the two-week limitation, we could have become more involved in the lab research. We also feel that if the program were longer it would not have been necessary to have two lectures per day. This would have given us more time to absorb the lectures and lab assignments. In addition, we could have had more extensive tours of the Berkeley laboratories so that everyone would have a chance to see the laboratories of their interest.

The schedule was so busy that we had little time to meet new friends and tour the area. Because we came from such varied backgrounds, many of us could have used the extra time to explore nearby San Francisco. We also feel that we should have been instructed to bring more spending money.

There were many important scientific questions in the program. They included understanding and finding cures for cancer and AIDS. Research on DNA is creating many new issues, such as mapping the human genome and DNA repair. The aging process is also being studied intensely.

In the lab, we learned the principle by which cells repair DNA damage due to mutagenesis. We actually participated in the processes of gel electrophoresis, DNA labeling, and a Southern blot, worked with plant and animal cell cultures, and learned how to manipulate and interpret data from the results.

Although we may not all be going into DNA repair, the work we did in the laboratory has positively influenced our choice of a science-related career.

Rajeev Dujari
Kim Hawley
Rebecca Kaplan
Julie Kittams
Tracee Watkins
Kristie Willet

## Carcinogenesis

Our experience at the DOE-LBL Life Sciences High School Honors Program has first and foremost shown us that the life sciences are interconnected. We have learned that scientists performing strikingly different types of research are sometimes trying to answer similar questions and that research in one area of the life sciences often has bearing on several other areas. Some of our morning lectures addressing carcinogenesis research evoked the same questions as our after lab sessions, in which we found out about other areas of cancer research. It was exciting for us to realize that a single scientific "discovery" might be the product of diverse research in many seemingly unrelated areas. We feel that it is the necessity of looking at a problem in several different aspects that makes science interesting, and certainly the life sciences offer many opportunities for this type of thinking. We have also become aware of the many personal rewards to be gained by pursuing a scientific investigation. This program has helped us to realize that although science takes much hard work and patience, it is also interesting, fun, and personally satisfying. Different lecturers and lab directors, such as Dr. Gunther Stent and Dr. Gerri Levine, have shown us the fulfillment which can be derived from meeting the challenges encountered in scientific research.

By bringing together fifty-five individuals from all parts of the country and several foreign countries, this program has fostered an atmosphere of open thinking and camaraderie resulting in a close-knit group of many new friends. We feel that we have benefited from the diversity of geographic origins, scientific backgrounds, and personalities of our fellow participants in the program. Questions raised by the participants during and after the lectures have been lively and have indicated the wide range of our group's interests in the life sciences. Relationships with others we have met at LBL have also been very rewarding. The directors of this program have helped us to have an organized, full, and enjoyable two weeks, and our chaperones have also helped keep events moving smoothly. The lecturers and the scientists directing our lab have introduced us to several exciting current research areas in the life sciences, and we especially appreciate their encouraging us to ask them questions

about their various research interests. The instructional level has been challenging yet understandable, and the program has stimulated our curiousity in both the areas we studied and in science in general.

The length of the program gave us time to gain exposure to a broad range of topics in the biological sciences as well as an introduction to some lab techniques widely used in modern biology. We feel that the introduction to scientific research we have received will prove very valuable, and the exposure has strengthened our desire to continue in scientific investigation in the future. We would like to suggest that next year's schedule include one morning lecture and an occasional evening lecture rather than two morning lectures; this schedule would allow for more time in labs as well as more time to digest the information presented. We also think that a longer program would be beneficial, giving us even more exposure to scientific research. Overall we found the program to be stimulating and enlightening, and we had a great time too.

The program has piqued our curiosity about several current topics of biological research. Lectures have interested us in such subjects as the mode of action of the AIDS virus, the relationship between differentiation and cancer, the development of the nervous system, the use of oil-bearing plants as renewable energy sources, and the processes of chemical carcinogenesis. Our laboratory sessions have provoked our interest in several topics of cancer research, including the relationship between genetic damage and cancer, the growth of epithelial cells in culture for cancer research, the transformations that carcinogens (such as benzopyrene) undergo in the cell, and the role that stress may play in inducing cancer. We have gained an introduction to some of the lab techniques used to study these topics; we have learned about the uses of various types of chromatography, radioactive labeling, antibody labeling, and electrophoresis. We also had the opportunity to do hands-on work in performing a Lowry protein assay, running an electrophoresis gel, and analyzing the results of SDS-PAGE to determine an unknown protein's approximate molecular weight. Clearly, we have discovered that there are many exciting areas for future study in the life sciences.

Our curiosity has led us to form numerous questions about these topics. We wonder how AIDS-infected cells can be effectively recognized and destroyed, what is the role of the extracellular matrix in transforming a normal cell into a cancerous cell, how the nervous system develops and functions, how genetic engineering can be used to develop plants which can be used as energy sources, and how carcinogens transform cells. We hope that we will help to answer these and other questions in the life sciences in the future. The DOE-LBL Life Sciences High School Honors Program has helped us immensely by giving us a taste of the excitement found in life sciences research. Our time at LBL has provided us with many new insights and ideas, and our experience will benefit us

greatly in the future. We cannot thank the Department of Energy enough for making possible our participation in this program.

Katherine Shiue
Christopher Smith
Jeanine Williamson
Wayne Yu

## Red Blood Cell Transport and Oxidative Stress

In this report, we will analyze three areas of concern: lectures, labs and extracurricular activities.

### Lectures

The lectures on the whole were excellent, due to the well prepared structure of the program. The multitude of topics was diverse enough to capture the interests of all the students attending. We were especially impressed by the presentations of Mina Bissell, Melvin Calvin, Jay Levy, and Alexandre Quintanilha. We would like to recommend for next year's program a lecture concerning science or medical ethics. In addition it would have been advantageous if the LBL laboratory tour was scheduled earlier in the program. Besides these few comments, little else remains to be stated pertaining to the lectures.

### Laboratory

Credit must be given to Dr. Alex Quintanilha for his vigorous efforts in running two lab groups under adverse conditions. We were misinformed about the objective of the lab. Instead of receiving a lab on "red blood cell transport and oxidative stress," we were assigned to a lab on "nerve impulses and oxidative stress." Furthermore, we were disappointed in not being exposed to a working lab environment. We appreciated the tours, but we had hoped for a session allowing for hands-on experience. We strongly suggest more laboratory experience in the future because we consider it to be an important part of the curriculum. It would be useful if background information covering the essentials of our research topic could be sent to us prior to the program in order to facilitate our lab experience.

### Extracurricular Activities

We were very impressed by the efficient execution of the activities. All of the scheduled programs provided us with an educational experience and a good source of entertainment. The exploratorium offered the greatest amount of interest to us.

One suggestion we would like to make is for the administration to offer a complete schedule of the two-week period. This would allow the students flexibility in setting up their daily schedules.

**Conclusion**

In summary we feel that our experiences at the University of California/Lawrence Berkeley Laboratory have contributed to our understanding of science as it applies to the world today. The lectures were interesting and educational. A great deal of credit must be given to the lecturers, who prepared comprehensive and enriching discussions. Although our two-week program was too short to become part of the laboratory operations and research, our exposure to the topics has allowed us to familiarize ourselves with the technology utilized in science today as well as realizing the opportunities open to us for the future. The social activities in which we participated were exciting and fun. The planned evening events appealed to the diverse interests of the students and were entertaining as well as informative. We, as a group, applaud the efforts of the coordinators, professors, doctors, and counselors in their efforts to promote the success of the program. We encourage the Department of Energy to continue this program in order to expose the students of the future to the science field.

Eva Birnbaum
Michelle Enger
Richard Lupia
Niraj Patel
Jeff Ayer
Kristan Boyd
Michael Drennan
Carol Gaudette
Carl Jackson

LIFE SCIENCES

HIGH SCHOOL HONORS PROGRAM

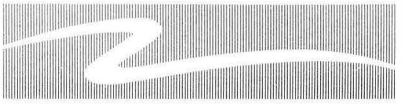
# Counselors

A key element in the achievement of LBL's goals for the High School Honors Program was the employment of UCB science and education graduate students as counselors. These employees lived with the students at the Clark Kerr Campus, participated in all the social activities and maintained disciplinary control of the students on a 24 hour/day basis. An important selection factor was knowledge of science research; thus the counselors provided a critical link between the students and the lab curriculum. Evening discussion groups were organized by the counselors and some of them attended the lecture series.

(L to R standing) LBL staff Rebecca Palmer, Helen Leung, and Jan Smith; Counselors Christine H. Ho, Pete Dunten, Christine S. Ho, Janet Levenson and David Zingmond. (Seated) Bruce Berkoff, Peter Weinstein and David Hammer.

| | |
|---|---|
| **Bruce Berkoff** | Ph.D. student in Biophysics at University of California, Berkeley. Bachelor's degree in Physics awarded from Princeton University. |
| **Peter Weinstein** | Master's degree student in Education at University of California, Berkeley. B.A. in Botany awarded from University of Michigan. |
| **Pete Dunten** | Ph.D. student in Biochemistry at University of California, Berkeley. |
| **David Hammer** | Ph.D. student in Physics, University of California, Berkeley. |
| **Christine H. Ho** | Ph.D. student in Sociology at University of California, Berkeley. Bachelor's degree in Social Studies awarded from Harvard University. |
| **Christine S. Ho** | Bachelor's degree in Biophysics from University of California, Berkeley. |
| **Janet Levenson** | Master's degree student in Education at the University of California, Berkeley. B.A. degree in Social Welfare awarded from UC Berkeley. |
| **David Zingmond** | Ph.D. student in Biophysics at University of California, Berkeley. B.A. degree awarded from Stanford University. |

LIFE SCIENCES



HIGH SCHOOL HONORS PROGRAM

# Social Activities

- Dinner and awards banquet to honor students
- Oakland "A's" vs. Kansas City Royals baseball game
- Excursion to San Francisco, Golden Gate Park
  - visit Steinhart Aquarium
  - visit Japanese Tea Garden
  - visit De Young Museum
- Hike to the ocean at Point Reyes National Seashore
- Tour the famous San Francisco Exploratorium
- Field trip to Lawrence Hall of Science
- Barbecue Picnic - softball games, swimming and relaxing
- Friday night at the Movies

# 1987 Awards Banquet

Introduction

**Alexandre Quintanilha**

"Education and the Department of Energy"

**Jo Ann Elferink**
*Manager*
*San Francisco Operations Office*
*U.S. Department of Energy*

Student Speakers

**Theresa Simmonds** *Pennsylvania*

**Michael Drennan** *Texas*

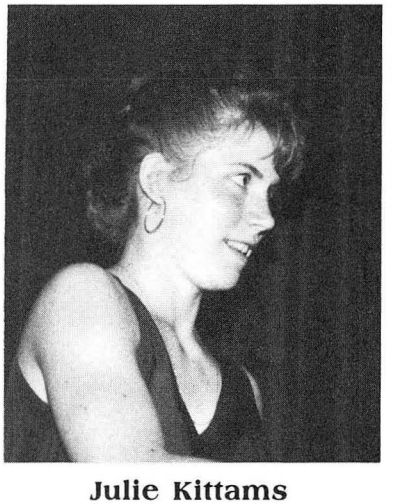
Awards Presentation

**Jo Ann Elferink**
**David A. Shirley**

# Participating Students

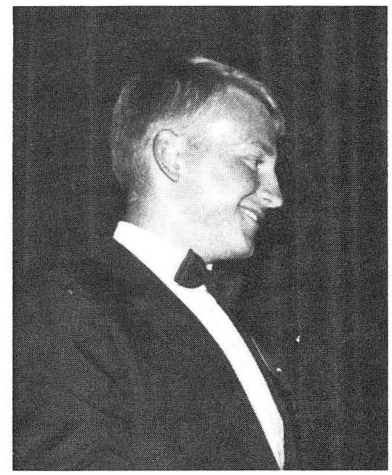
JoAnn Elferink, head of the DOE-San Francisco Operations Office, presents award to Claudia Santosa, High School Honors Program representative from New York.

**Jeanine Williamson**
Alabama

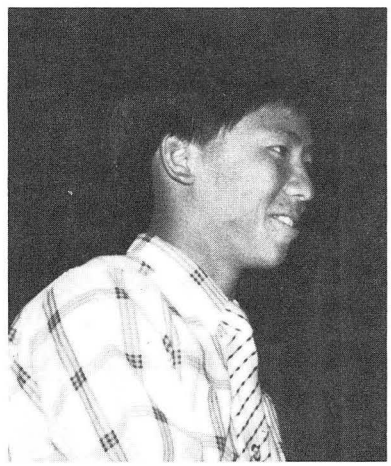


**Julie Kittams**
Alaska

**Jeff Ayer**
Arizona



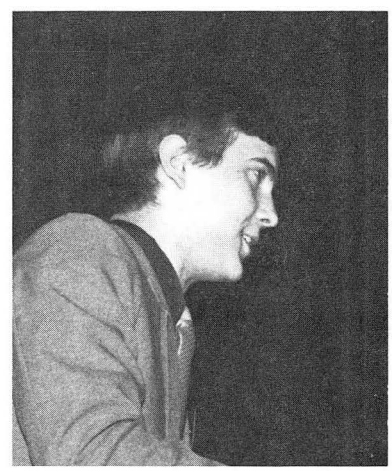
**Craig Murders**
Arkansas



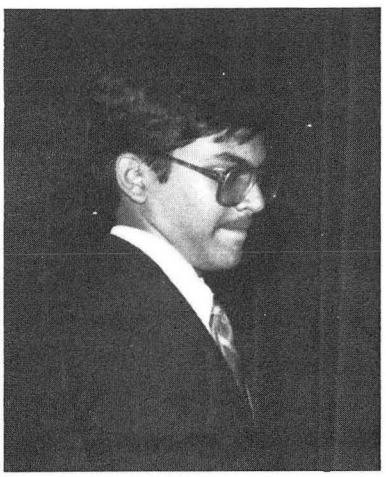
**Goodwin Liu**
California

**Rebecca Kaplan**
Canada

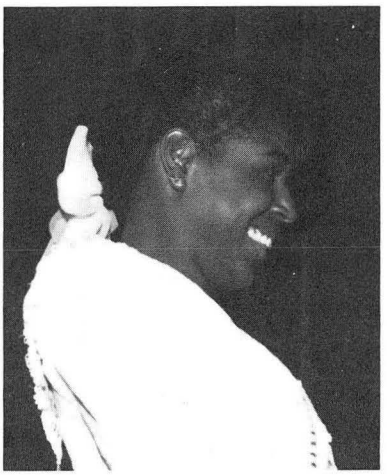
**Laurel Steele**
Colorado



**Richard Lupia**
Connecticut

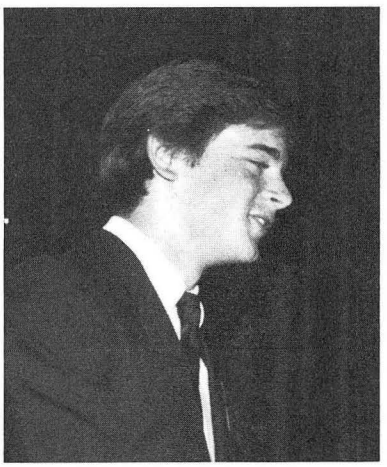


**Rajeev Dujari**
Delaware

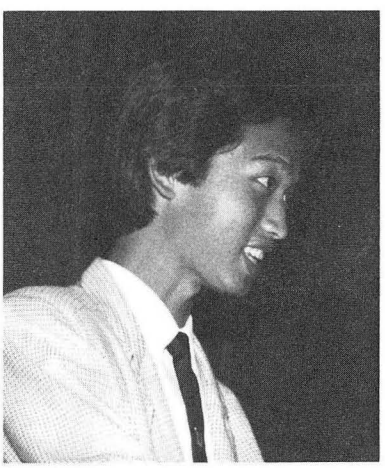


**Renee Cooley**
District of Columbia

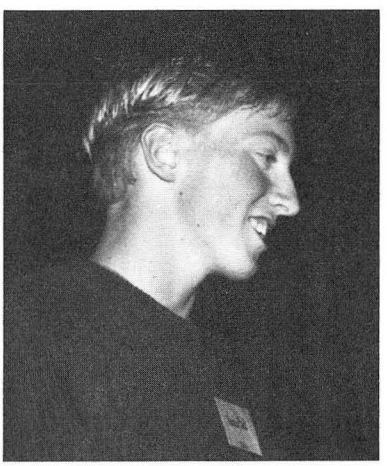
**Christopher Smith**
Florida



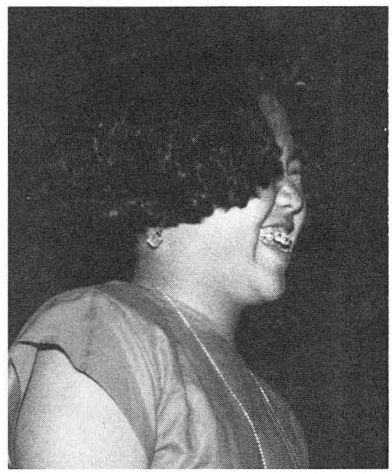
**Stephen Walker**
Georgia



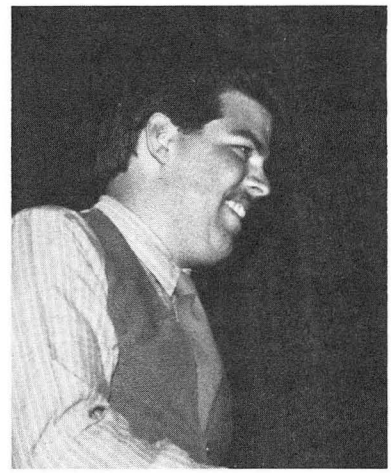
**Lewis Lee**
Hawaii



**Vance Bell, Jr.**
Idaho

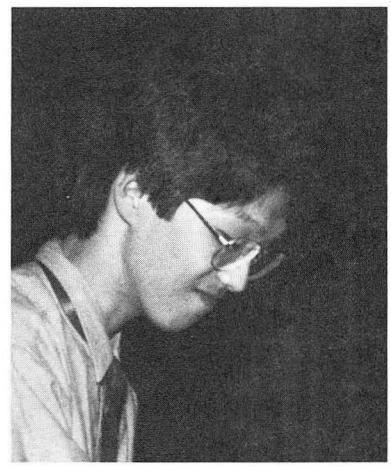


**Eleanore Kim**
Illinois



**Robert Kernodle**
Indiana

**Michelle Enger**
Iowa



**Toru Iwasaki**
Japan

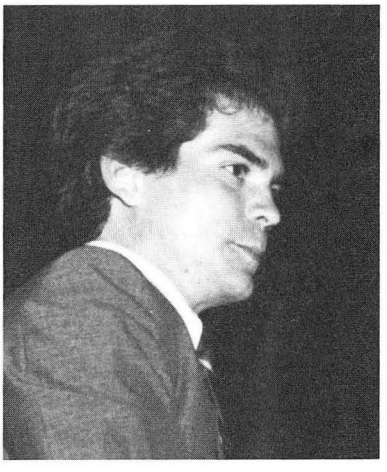
**Penny Menhusen**
Kansas

**Sonya Johnson**
Kentucky

**Julie Janjula**
Louisiana

**Jennifer Bragg**
Maine

**Albert Hsia**
Maryland

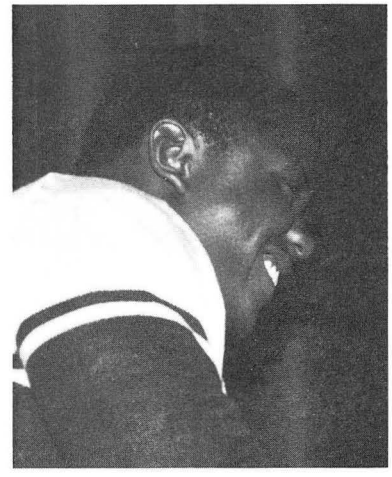


**Bryan Blood**
Massachusetts

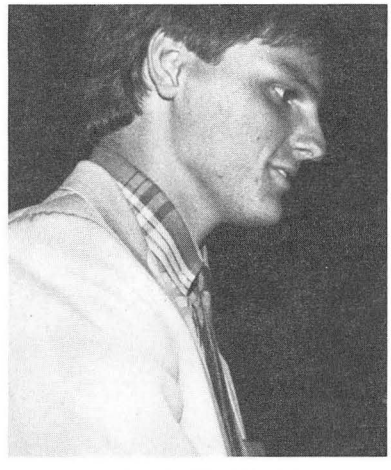
**Niraj Patel**
Michigan

**Heather Zwickey**
Minnesota

**Tracee Watkins**
Mississippi



**Carl Jackson**
Missouri



**Cort Raithel**
Montana

**Valerie Baker**
Nebraska

**Katherine Shuie**
Nevada

**Carol Gaudette**
New Hampshire

**Jan Brzosko**
New Jersey

**Eva Birnbaum**
New Mexico

Photo
not available

**Claudia Santosa**
New York

**Lawrence Lee**
North Carolina

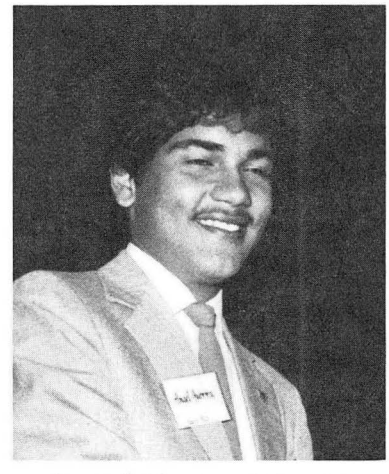
**Daron Scherr**
North Dakota

**Kristie Willett**
Ohio

**Wayne Yu**
Oklahoma

**Darcy Arriola**
Oregon

**Theresa Simmonds**
Pennsylvania

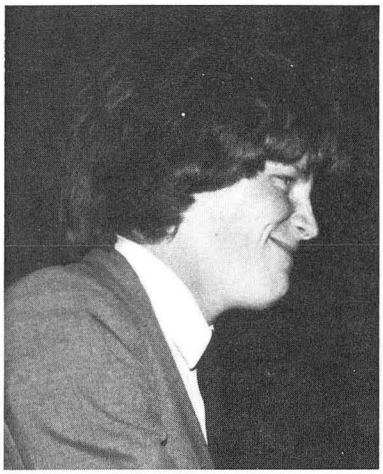


**Angel Guerra-Torres**
Puerto Rico

**Jason DeGoes**
Rhode Island

**Erika Manning**
South Carolina

**Kristan Boyd**
South Dakota

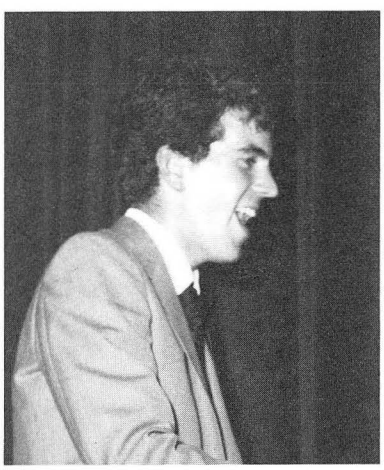


**Michael Aldridge**
Tennessee

**Michael Drennan**
Texas

**Kim Hawley**
United Kingdom

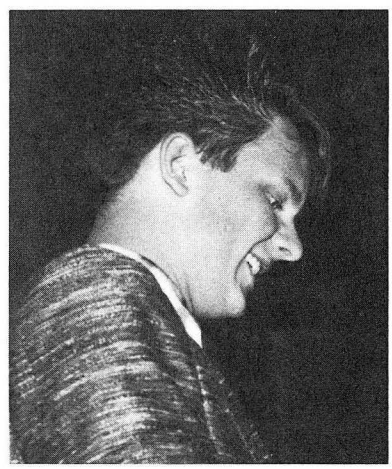
**Heather Heppler**
Utah



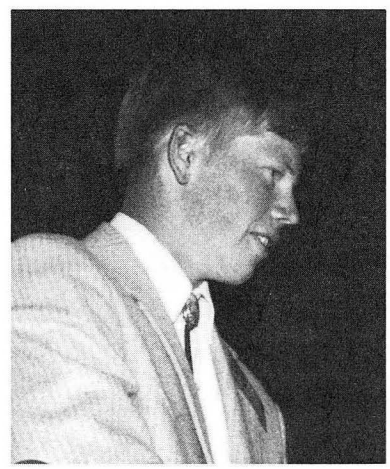
**Robert Greer**
Vermont

**Laura Coltrane**
Virginia

**Leslie Widdison**
Washington



**James White**
West Virginia



**Boyd Saul**
Wyoming