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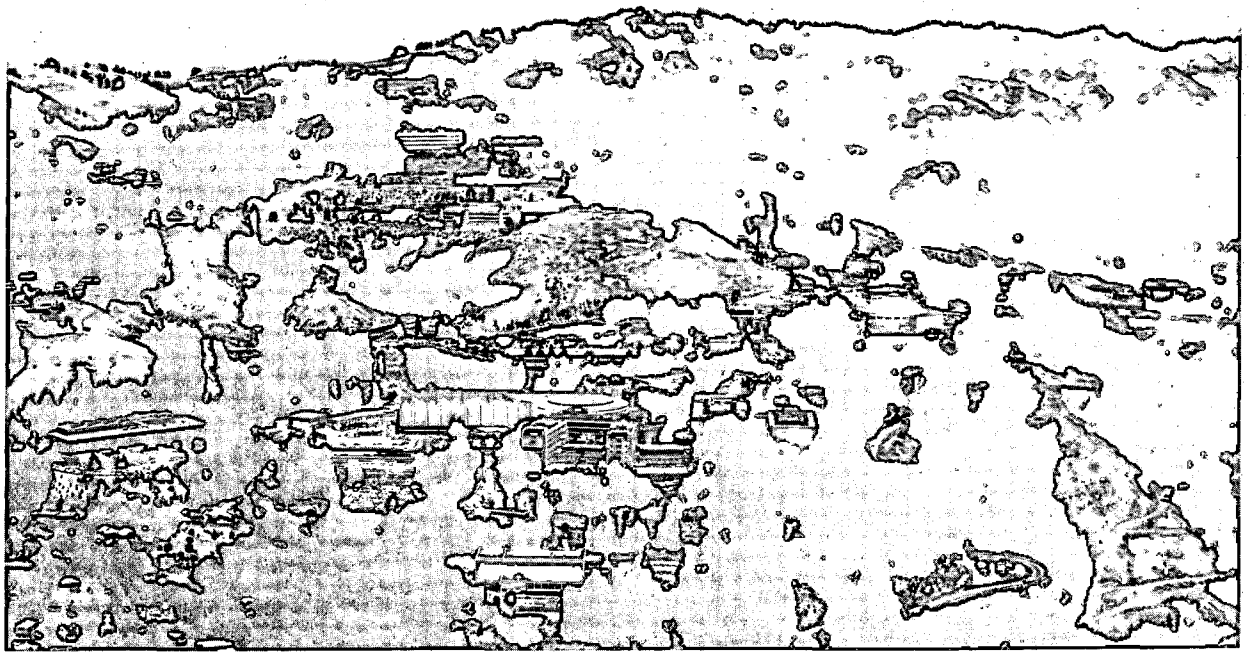

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LAWRENCE BERKELEY LABORATORY

CENTER FOR SCIENCE AND ENGINEERING EDUCATION:

1987 ANNUAL REPORT

March 1988

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I. INTRODUCTION

Part of the Lawrence Berkeley Laboratory's mission as a national laboratory is to "educate and train future generations of scientists and engineers." In order to carry out this part of its mission with maximum effectiveness, in 1987 LBL established, with Department of Energy funding, a Center for Science and Engineering Education (CSEE) in the Office for Planning and Development. By consolidating precollege, college, and minority outreach programs that were previously administered by several different LBL divisions, CSEE provides a foundation for expanding and enhancing LBL's educational efforts.

Also in 1987, LBL established a partnership with the Lawrence Hall of Science (LHS), an internationally recognized science museum, teacher training center, and curriculum development center. This partnership between a national laboratory and a science education center provides unique opportunities to promote teacher enhancement, materials and curriculum development, and public understanding of science and technology. The LBL/LHS collaborative programs initiated in 1987 are described in Section 3.5 of this report.

The statements of college students and of high school students and teachers who have participated in education programs at LBL illustrate that participation in an education program at a national laboratory can represent a turning point in a person's life. It is an experience unequaled in its contribution to the individual's scientific career awareness, knowledge of state-of-the-art science, and professional development. Many representative comments of program participants appear on the following pages.

By increasing scientific literacy and career awareness throughout the population, LBL's precollege and minority education programs help to increase the size of the pool from which future scientists and engineers can be drawn. Also, by giving the faculty at minority colleges access to state-of-the-art scientific facilities, the minority education programs give these individuals the opportunity to make significant contributions in their fields. Thus, the overall goals of LBL's Center for Science and Engineering Education are to promote an understanding of science, its process and frontiers, and to maximize the potential for scientific participation and achievement among program participants and their students.

II. UNDERGRADUATE PROGRAMS

2.1 Introduction

Two undergraduate programs, the Laboratory Co-op Program and the Science and Engineering Research Semester, comprise the core of current activity in undergraduate student education sponsored by LBL's Center for Science and Engineering Education. These programs provide opportunities for top undergraduate students from colleges and universities throughout the nation to work on advanced research projects. The undergraduate programs are designed to attract participants who plan to pursue careers in science, engineering, and education fields relevant to future national science needs. The primary goal is to educate and train scientists and engineers to meet the nation's future manpower requirements in the energy and general sciences.

Since its beginning in 1969, the Lab Co-op Program has provided a mechanism to sponsor undergraduate students in engineering and fundamental science studies with specific application to biology, medicine, renewable energy resources, conservation, earth science, fusion, material science, heavy ion nuclear science, particle physics, astrophysics, and instrument development. The introduction of the Science and Engineering Research Semester (SERS) in 1987 has expanded LBL's undergraduate educational commitment substantially. Through a combination of hands-on use of laboratory research facilities and direct interaction with senior scientists, the LBL Co-op Program and SERS Program provide undergraduate students with practical insight into the real world of research; provide a positive influence on their educational goals; and supply a model for choices they will soon be making about future life direction.

Lawrence Berkeley Laboratory, with its varied on-going research efforts and its interdisciplinary approach, provides an ideal environment for student research placement. The research projects are supplemented by LBL's physical proximity and contractual relationship to the University of California, Berkeley campus, which allows LBL undergraduate program participants to attend University classes and to use the University's extensive library system. However, the most impressive resources available through the Lawrence Berkeley Laboratory's undergraduate programs are human resources. Participants have consistently been challenged by the intellectual effort in progress at LBL, and the result has always been a gain for both scientists and students.

The individual dedication of researchers at LBL to science education has been a key to the long-term success of the Lab Co-op Program and the reason LBL has been able to expand its undergraduate education effort to include the SERS Program. Many of the students continue their relationship with the research group to which they have been assigned, returning for additional summers or as graduate students, and have applied their experience to further research as they have progressed into careers. Thus, the LBL research staff has provided science education in its broadest sense -- fostering a process by which curiosity is increased, eagerness for knowledge is encouraged, and fascination with what remains unknown is developed.

2.2 Science and Engineering Research Semester (SERS)

Recruitment and Selection

The Science and Engineering Research Semester (SERS) is a new DOE program that hosted its first group of students for the Fall Semester, 1987. SERS students were recruited nationally, following the recruitment standards used for the summer Lab Co-op Program. The application process, coordinated by the Department of Energy, leads to placement at one of five national laboratories, including LBL.

The selection and placement process is based on several factors: (1) junior or senior standing with a minimum grade point average of 3.0 (on a 4.0 scale), (2) letters of reference, (3) statement of interests and objectives, (4) student access to research facilities at the home college or university, and (5) ability to place the student in a research project compatible with his or her interests. Recruitment and selection reviews occur twice per academic year to correspond with placement in the Fall or Spring Semester Program. LBL hosted seven students during the first SERS session, which ended in December 1987.

Activities

The primary objective of the SERS Program is to demonstrate to the participants the key issues in energy-related research and development, as well as to introduce them to the multidisciplinary nature of research. A secondary objective includes providing guidance to the students in choosing career paths with emphasis on graduate school as an educational goal.

Students participate in existing Laboratory research projects on a full-time basis for 15-17 weeks each semester. Students wishing to take a course from UC Berkeley are given release time to do so. Credit for the UC Berkeley course is awarded at the completion of the semester and a transcript is provided to the student's college or university. Credit for the LBL research effort may also be arranged with the student's college or university. The SERS students are also encouraged to take advantage of the many ancillary opportunities available through LBL: seminars, lectures, and facility tours are routinely available.

Evaluation

At the end of the semester, SERS students are required to prepare a research report and a project evaluation to be co-signed by their project advisor. Project advisors concurrently prepare evaluations of the student's contributions. Both sets of project evaluations are officially recorded.

Four of the five students who completed the Student Program Evaluation form in December 1987 stated that the SERS Program had produced a marked change in their academic goals. Their comments included, "I definitely want to attend graduate school now," and, "My future goals have become more coherent." Four out of five also said the program had markedly improved their skills and technical knowledge.

The advisors' ratings of the students were uniformly high. The following comments illustrate their satisfaction with students' performance:

* Overall, Bea made significant contributions to our research. By the end of her stay, she was beginning to make conceptual contributions as well.

* Tim was an excellent worker and he will make an outstanding addition to any engineering or scientific organization that he may elect to join in the future.

* Gayla was highly motivated to succeed. She learned quickly and performed assigned tasks very well. She often worked long hours and paid careful attention to the quality of her work.

The only criticism of the program came from an advisor who lamented that his student couldn't stay for six months instead of three.

2.3 Laboratory Co-op Program

The Laboratory Co-op Program is intended to demonstrate the interdisciplinary nature of energy-related research to top students from a variety of academic majors. By providing hands-on laboratory experience and educational support, the program assists students in their pursuit of graduate credentials and provides an opportunity for students to use facilities not readily available at their own college or university.

The undergraduate student program is comprised of two elements: (1) a 15-17 week, locally recruited, academic year program, and (2) a 10-week, nationally recruited, summer program. Except for the local recruiting, the academic year Lab Co-op Program follows predominantly the same pattern as the SERS program described previously. The summer Lab Co-op Program is described in detail in this section.

Recruitment and Selection

Requirements for the summer Laboratory Co-op Program include: (1) junior or senior standing at an accredited college or university, (2) a minimum 3.0 grade point average, (3) submission of all application materials by a February 1 deadline for the following summer program. Selection of each of the 12 to 14 students for the program is based on the applicant's academic record, research goals, and the recommendation of instructors and other references.

In addition to a standard application form, students are asked to submit a written statement of purpose and science course grade list. Applicants arrange for an official transcript of their grades to be sent from the registrar; they also request letters of reference from at least two sources. To avoid a repeat of information available from a careful reading of the transcript, LBL provides detailed instructions to the reference letter authors about what information should be discussed in the letters. This practice also insures comprehensive information from the references about the student's goals and accomplishments in addition to grades. Thus, the letters of reference provide a necessary, qualitative dimension to the selection process.

Applications for the summer Lab Co-op Program are sent each year to colleges and universities throughout the nation. During the past seven years, participants have represented the following regions of the country: 47.1% West Coast, 26.5% East Coast, 20.6% Midwest, and 5.9% South. The 1987 participants came from Bryn Mawr, Cooper Union, the University of

California at Davis, the University of California at Berkeley, Emory University, the University of Maryland, the University of Chicago, Harvard University, and Georgetown University.

Special recruiting emphasis is placed on smaller colleges and universities where laboratory equipment and facilities may not readily be available to the students. The recruitment effort is enhanced by personal contact with individual faculty and science department chairs, who are given an opportunity to personally select a promising student to sponsor in the application process.

These techniques have generated consistently well-qualified applicants. Not only is the Lab Co-op Program consistently attracting national interest on the part of undergraduate students, but, through use of the faculty recruitment assistance described above, the academic quality of the students who apply has increased over the past three years. The 1987 summer Lab Co-op recruitment effort yielded over 175 applications for the 12 positions available. The average grade point average (GPA) for the applicant pool was 3.5 on a 4.0 scale. The Lab Co-op participants, however, both summer and academic year, have always been among the top academic performers, independent of the improving GPA of the overall applicant pool.

Summer Program Activities

Participants are associated with members of the LBL scientific staff for 10 weeks in a training program designed to provide research experience in lab projects ranging from physics, chemistry, or engineering to nuclear science, computer science, or environmental studies. All students are expected to participate full-time on a research project.

The 1987 summer Co-op Program sponsored research in the following LBL Divisions: Materials and Chemical Sciences, Computing, Chemical Biodynamics, Nuclear Science, Biology and Medicine, and Applied Science. Several project opportunities were offered in some of the divisions. This approach represents a major departure from earlier years when all summer Co-op placement was restricted to projects within the Applied Science Division. This expanded use of LBL resources has allowed the Program to continue to meet the varied interests of students and to assure the maximum use of LBL facilities.

In addition to full-time research participation, the summer Co-op Program requires weekly meetings of the participants to discuss their scientific progress. Directed by a staff scientist, these discussions lead, during the final weeks of the program, to individual presentations in which the

students summarize the content of their research.

In 1984, summer Co-op students were given a short course on how to give effective scientific presentations using overhead transparencies. Because this course had a large impact on the quality of the presentations, it was used as the basis for a videotape which is now shown to all participants in the undergraduate programs.

The weekly student/scientist discussions are supplemented by the Summer Lecture Series (see Appendix B), which is also attended by participants in LBL's Summer Teacher Program. Speakers are LBL senior research staff members who address topics of broad scientific interest.

LBL provides the summer Co-op students with tours of LBL facilities and access to all research equipment and facilities associated with the individual research projects, including state-of-the-art computer facilities. Participants also receive access to a full range of summer activities through the University of California and to the LBL and University library systems.

Evaluation

Each research project supervisor is asked to provide a written evaluation of the student's progress. Concurrently, the students are given evaluation forms. The evaluations are carefully reviewed by Co-op Program staff for use in future planning.

Student comments indicate that the program is an extremely valuable educational experience:

* My purpose in coming here was to gain some lab experience and see the attitudes and environment of a lab such as LBL. The tests I made greatly improved my practical lab abilities, and the people I worked with helped me to see a wider spectrum of careers, and attitudes about those careers, than I had seen before I came.

* This was a great opportunity for me to learn technical skills which I didn't have a chance to learn at school. I also gained self-confidence in successfully carrying out a job.

* I learned quite a lot about the chemistry I was working with. I also got a chance to learn new skills and refine old skills. My motivation to accept responsibilty increased in that I had to

make decisions in the lab on my own and learn to use my judgment.

* I came to LBL with very little knowledge in nuclear physics and computer programming. I feel that I have gained considerably in both of these areas... But perhaps more importantly, my work here has given me confidence in tackling difficult tasks involving new skills and knowledge.

Almost without exception, supervisor appraisals of the Lab Co-op students have been very positive. The following student characteristics are frequently praised:

* Intelligence, capability, and skill
* Ability to contribute to a research program
* Conscientiousness and persistence
* Ability to grasp a problem and learn quickly
* Motivation and independence
* Good judgment and problem-solving abilities
* Good attitude toward science and enthusiasm as a worker
* Ability to communicate well with scientists and colleagues

Data on each year's participants are added to a historical database that includes all participants in all of the summer Co-op Programs. LBL thus has the capability to "track" students over a longer period of time and, ultimately, to provide long-term statistics on the students' accomplishments.

As a new feature of the 1987 Program, each student was required to prepare a written report on his or her research project. These reports have been published in a separate document entitled Center for Science and Engineering Education: Undergraduate Programs (PUB-633, November 1987).

III. PRECOLLEGE PROGRAMS

3.1 Introduction

Throughout its history, LBL has earned a reputation for excellence in providing a world-renowned training ground for college students and young postgraduate scientists. Since 1983, this educational role has been expanded in response to urgent, nationwide demands for precollege educational reform: with the help of Department of Energy funds, LBL has launched four programs that provide precollege teachers and students with the opportunity to tap the Laboratory's rich human and scientific resources. In addition, in 1987 LBL developed several collaborative precollege education programs with the Lawrence Hall of Science.

LBL's programs for precollege students and teachers address the following educational goals, which were formulated by a committee of precollege education program directors from the DOE national laboratories:

* To stimulate student interest, understanding, and appreciation of science, mathematics, and technology, so that more students will:

  1) pursue careers in science, engineering, technology, and science and mathematics education.

  2) be scientifically literate.

* To assist and support educators in providing quality science and mathematics instruction by:

  1) updating teachers' backgrounds in science and mathematics content.

  2) improving teaching methods and strategies; for example, in laboratories, demonstrations, and computer applications.

  3) increasing educators' awareness of science and engineering careers.

  4) increasing educators' awareness of the relationships among science, technology, and society.

5) enhancing and improving instructional materials.

6) providing access to resources and equipment.

7) recognizing and rewarding good teaching.

The Summer Teacher Program, started in 1983, gives high school and junior high science and mathematics teachers an opportunity to update their knowledge and revitalize their interests by spending a summer in research positions at LBL. Qualified teachers with bachelor's or master's degrees in physics, chemistry, biology, engineering, or mathematics are hired for specific Laboratory projects in which they gain firsthand knowledge and become an integral part of the scientific process.

An outgrowth of the LBL Summer Teacher Program, the Residence in Science and Technology (REST) program was started in 1985 as a consortium of three national laboratories--Lawrence Berkeley Laboratory, Argonne National Laboratory, and Brookhaven National Laboratory. In 1987, REST provided seven nationally recognized science teachers with summer research positions at five national laboratories.

Also launched in 1985, the Science Week Award has brought more than 100 outstanding students and teachers to visit LBL and interact with researchers in small group presentations. The program includes tours, lectures, and hands-on experiments.

A new program started in 1987, the High School Honors Program in the Life Sciences, brought 55 top-achieving high school science students -- one from each of the 50 states, the District of Columbia, Puerto Rico, Canada, England, and Japan -- to LBL for two weeks of lectures and laboratory experiences. The program was one of four DOE High School Honors Programs nationwide.

LBL's approaches to enhancing precollege education are firmly grounded in educational and psychological research. Educational Testing Service researchers have found that Scholastic Aptitude Test (SAT) scores in math and science are increased when students are exposed to teachers who have worked in laboratories or in industry and bring a real-life perspective on math and science to the classroom. It is precisely the opportunity for such work -- often a once-in-lifetime experience -- that the Summer Teacher Program and REST provide.

Socialization studies show that student achievement in a wide range of subjects is augmented by exposure to appropriate role models. In addition, a great deal of research, including

the work of Swiss psychologist Jean Piaget and his followers, shows that performing hands-on experiments is essential to the development of math and science skills. In the Science Week Award program and the High School Honors Program, role models include nationally renowned scientists -- even Nobel laureates; hands-on experiments are an integral and important part of both programs.

3.2 Summer Teacher Program and Residence in Science and Technology (REST)

History

The LBL Summer Teacher Program (STP) was started in 1983 as a six-week pilot program funded by the Department of Energy. Under the guidance of the program director, six San Francisco Bay Area science and mathematics teachers met to determine the role of a national laboratory in precollege education. The teachers worked in research laboratories approximately 50% of the time; they spent the remaining time investigating Laboratory facilities, attending lectures and seminars, and preparing a paper summarizing their recommendations for future precollege programs at LBL.

The report prepared that first summer, entitled "The Role of a National Laboratory in Precollege Education," became a reference document not only for the LBL Summer Teacher Program staff, but also for precollege education program developers at at the Lawrence Hall of Science in Berkeley, the University of California, the California State Colleges, and other DOE national laboratories. Among the main recommendations were that ample time be devoted to the teachers' laboratory research assignments and that teacher programs at national laboratories build upon the knowledge of teachers who already have a basic background in science. The teachers recommended further that, if the national laboratories become involved in training teachers who are now teaching science but have backgrounds in other fields, the expertise at university schools of education be utilized.

The idea for the Residence in Science and Technology (REST) Program was conceived at the end of the summer of 1984 at a conference on educational programs at the national laboratories. The conference, held at Argonne National Laboratory, was attended by three staff members of the LBL Precollege Education Programs. In a meeting of education project leaders from laboratories already involved in precollege program development, Roland Otto, representing the LBL team, presented the concept of a multilaboratory outreach to

public school educators. In addition, the closing summary of the conference included a discussion of the "multiplier effect" of investing in teachers: since a teacher typically reaches about 150 students per semester, investing in teachers stretches program dollars to reach the maximum number of students.

Representatives from Argonne National Laboratory and Brookhaven National Laboratory agreed to join LBL in a multi-laboratory outreach, and, in 1985, REST sponsored six teachers at these three laboratories. Since then, Pacific Northwest Laboratory, Lawrence Livermore National Laboratory, and Oak Ridge National Laboratory have joined the REST consortium; in 1987, seven teachers recieved support from the participating laboratories.

In 1985 and 1986, a prospective or first-year teacher was included in the progam. These recent college graduates were capable and comfortable in the research environment, but recognized a lack of confidence in their teaching skills. The interaction between the experienced, often master, teachers and the novice teachers was a dynamic one in which there was much communication and sharing on the subjects of science, technology, and teaching methodology.

The 1987 Summer Teacher Program brought 11 teachers to LBL, including two REST teachers and four teachers sponsored by LBL's minority education programs, which were established to promote quality science education at institutions serving predominantly minority populations. During the six-week program, participants spent 80% of their time in research laboratories, and 20% attending lectures, tours, and a twice weekly seminar entitled "Teaching Scientific Investigation." The seminar brought in guest speakers and gave the teachers a forum for exchanging ideas on how to translate their research experiences into classroom activities. All participants prepared materials to take back to their classrooms and completed both oral and written reports on these materials, as well as on their scientific research.

Each year, the Summer Teacher Program has evolved based on new ideas generated by the staff and on the feedback of teachers attending the previous year. The number of participants and length of the program has varied from year-to-year according to available funding. Since 1984, participants have had the option of registering for university credits through the Summer Program for Educators offered by the Graduate School of Education at the University of California at Berkeley.

In 1986, at the California Administrators Conference, the State Department of Education recognized the LBL Summer

Teacher Program for establishing an exemplary partnership with the Albany Unified School District. Five teachers from Albany High School -- most of the science staff members -- have participated in the Summer Teacher Program.

Participant Selection

The Summer Teacher Program is designed for science and mathematics teachers possessing degrees in their fields. The process of selection has varied and evolved over the four years of the program. Originally, the superintendents of local school districts were notified and asked to recommend an outstanding science or mathematics teacher. As the program has grown and gained recognition, applicants have also been obtained by the following methods:

1. Former participants have given LBL the names of outstanding science and mathematics teachers who might benefit from the program.

2. Teachers have responded to an announcement with a tear-out interest form placed in the California Science Teacher Association Bulletin.

3. Many teachers, after hearing about the program, have contacted LBL and had their names placed on a master list of interested teachers.

4. The staff of LBL's minority programs has selected outstanding teachers from areas with large minority populations.

5. Teachers have contacted LBL after hearing Precollege Program staff members speak at professional meetings, such as the National Science Supervisors Association Annual Meeting, the California Partnerships Conference, the American Chemical Society National Convention, and the National Convention of the National Science Teachers Association.

6. In 1987, for the first time, a past Summer Teacher Program participant returned to LBL under the sponsorship of a research laboratory.

The program coordinator conducts a telephone interview with each of the prospective participants. On the basis of these interviews and the teachers' resumes, each teacher's potential for success in an LBL research laboratory is evaluated, and the most promising candidates are selected for participation in the program. The number of applicants selected is determined by available funding.

A separate procedure is used to procure applicants for the REST program. Outstanding high school and junior high school teachers are recommended by four professional societies: the American Chemical Society, the National Association of Biology Teachers, the American Association of Physics Teachers, and the National Council of Teachers of Mathematics. Invitations to apply are sent to all recommended teachers; final selection of candidates is made by REST coordinators and precollege program directors at the participating national laboratories.

Research Laboratory Assignment

The research laboratory assignment is the heart of the Summer Teacher Program and REST. Through this experience, teachers draw on rarely used talents, develop new skills, and gain a renewed enthusiasm for science that is transferred to their classroom work. In addition, they have an opportunity to use scientific equipment and instrumentation far more sophisticated than anything available on a limited school district budget.

On the basis of experience and interests, each teacher is matched to a research laboratory. The following methods are used to generate a list of laboratories in which the participants can be placed:

1. Former participating principal investigators are asked if they would like to take part again.

2. In Currents, the LBL weekly newspaper, stories are published explaining the programs and inviting interested scientists to participate.

3. The program coordinators contact principal investigators with research projects in areas matching the experience of teacher participants. This results both in placement of teachers and in referrals to laboratories more suited to the program needs.

In 1987, teachers worked on the projects listed below:

* Feasibility studies for a semiconductor laser

* Microencapsulation of inhalable atmospheric particles

* Determination of black carbon and total carbon in ambient air

* The effect of malaria on blood-forming stem cells (two teachers)

* Platelet formation from megakaryocytes

* Development of a charge stripper for the Heavy Ion Linear Accelerator

* Neutron activation analysis for dating objects and substances

* Determination of solubility product constants of sulfur-nitrogen complexes

* Blood-forming stem cells with limited self-renewal

* Determination of selenium in sediments, vegetation, and animal tissue samples from Kesterson Reservoir

Almost without exception, teachers in the program not only gain exposure to modern instruments but are given primary responsibility for their operation -- including such analytical instruments as atomic absorption spectrometers, gas chromatographs, electrophoresis systems, x-ray machines, and gamma-ray or nuclear-particle counters. They also have access to lasers, electron microscopes and a large array of electronic equipment.

The teachers become important members of the research teams, and they return to the classroom as original sources of scientific information for their students and peers. The impact of revitalized, enthusiastic, and motivated teachers on their students, as well as on administrators and other colleagues, will mean improved science education for thousands of students during each teacher's career. Moreover, the teachers' experiences at LBL can be translated directly into the classroom: students do activities based on their teacher's research project and receive firsthand accounts of the relevancy and sense of discovery that is part of scientific research.

Supplementary Activities

The Summer Teacher Program includes tours to give participants an overview of LBL research projects and facilities. In 1987, these tours included visits to the following:

* Neutron activation analysis experiment

* SuperHILAC

* Bevatron

* National Center for Electron Microscopy

Participants also attended a multimedia presentation on research at LBL, a lecture presentation on laboratory safety, and training sessions on CPR and first aid.

The LBL Summer Lecture Series (see Appendix B), which features LBL scientists internationally known for their research, is an important part of the teachers' experience. The series was started in 1983 to supplement ongoing summer programs for students. Speakers are still asked to target their remarks to college students, but this is precisely the level that is well received by teachers, as well as many LBL staff members.

The Summer Teacher Program tries to maximize participants' exposure to state-of-the-art developments in scientific research. In 1986, participants attended a seminar based on Opportunities in Chemistry, a report authored by a committee of distinguished chemists headed by George Pimentel. The teachers were asked to examine recent advances on the frontiers of chemistry. They discussed the current direction of research in chemistry, its relevance to society's needs, and its relevance to classroom science instruction. The group acknowledged that Opportunities in Chemistry clearly demonstrates that we can no longer have deep divisions separating the sciences: physics and chemistry, for instance, are an integral part of modern biology. The teachers also agreed that the report demonstrates the need for chemistry to be a common language for teachers in all areas of science.

The teachers concluded that educators should make an effort to interweave topics from chemistry, physics, and biology in a single course. As a result, some of the seminar participants may be among the first educators to translate current technology into teaching units which incorporate an interdisciplinary approach. For example, a chemistry teacher collaborated with a math teacher on a unit to teach logarithms in algebra and trigonometry courses in conjunction with practical applications from acid/base chemistry and pH.

The Summer Teacher Program includes regularly scheduled meetings to encourage and foster development of instructional materials based on the teachers' research assignments. In 1987, these meetings were formalized in the seminar entitled "Teaching Scientific Investigation." Each teacher was required to develop an instructional unit, activity, or problem set related to his or her research. Examples of materials produced include a cooperative learning unit on the

Kesterson Reservoir, laboratory activities on human blood cell identification and counting, and problems and experiments to accompany a lecture on the galvanomagnetic semiconductor laser.

Evaluation

Questionnaires completed at the end of the summer indicate that all participants feel that they have benefited from the teacher programs. The specific benefits they cite include deeper understanding of the scientific method, ideas for student projects, practical applications of topics that they teach, contacts with scientists, and increased confidence in their knowledge of scientific careers. The following comments are typical:

* I think I've gotten a little different feeling about the scientific method. When you just talk about it, you think it's a cut/dry set of steps that you follow. Here, you find out there are sometimes alternate steps. I worked on several ideas I will have students pursue as viable research topics in my research class this fall.

* This experience will help me to guide the students to a better understanding of science. It will enrich my science curriculum by providing new ideas and procedures.

* The greatest benefit was in seeing the math I use in class being used on the job.

* I gained contacts with "real, live" scientists and confidence in my ability to act as a spokesperson and advocate of science as an avocation and career.

* I will be more patient and careful in my teaching this fall. The broadening of my general knowledge will make me a better resource for inquisitive minds.

At the beginning of the 1986 program, the teachers filled out a program evaluation form based on their expectations and initial feelings; at the end of the program, they filled out an identical form based on their experiences. These forms revealed a transition from feelings of trepidation and anxiety about working in a research laboratory to feelings of excitement and competence.

On the first questionnaire, teachers made comments such as the following:

* I felt confused, overwhelmed, and unable to grasp what was going on or being said.

* There are some anxious moments involved in this kind of learning because mistakes can be costly. I find myself asking many questions before actually doing anything.

In contrast, the follow-up questionnaire revealed a newfound confidence:

* Anxious changed to excited when I actually got my feet wet.

* My learning experiences have been many... I will enter the classroom more intense and more well-rounded, exploding with new ideas and better things to tell.

It seems evident that a science teacher who has feelings of self-doubt and inadequacy about the prospect of entering a research laboratory will be less effective in encouraging students to pursue careers in science than a teacher who has worked in a research laboratory, feels competent in the skills needed to succeed there, and has experienced the excitement of scientific discovery firsthand.

Principal investigators are asked to complete a written evaluation of the program. Their praise for the teachers has been high, and they express firm belief in the worthwhileness of the program:

* She was truly exceptional... She very quickly assimilated our operational techniques in measurements of iridium and the sometimes complex statistical treatments necessary to reduce the data. She was very well organized and efficient, and she came up with innovative ideas for presenting data and solving problems. She was helpful with suggestions about other parts of our program not related to her problem. Such teachers can be a very effective conduit in transferring to high school students the scientific and mathematical background necessary for some of the academic decisions they must make in high school and college.

* I was particularly impressed with his enthusiasm and capacity for grasping concepts to which he may not have had a great deal of exposure previously. I feel any school should be proud of having him on the faculty.

* His enthusiasm, diligence, and meticulous care was a big help to our program this summer. More important, these are the qualities we consider desirable in high school students. He prepared a teaching document which could be used in his classes and which emphasized these points. With participants such as this, the LBL Summer Teacher Program will have a significant effect on science teaching in the Bay Area and elsewhere.

Follow-up meetings for past participants were held in 1985, 1986, and 1987. At these meetings, teachers expressed their feelings about the value of their experiences in the LBL Summer Teacher Program. A recurring comment was that when they discussed their summer research experiences in the classroom, they had the undivided attention and interest of the students. Many teachers expressed a renewed commitment to carrying out experiments in the classroom. Many also said that they now had a better understanding of how students feel when approaching a new experiment.

3.3 Science Week Award

History

Science Week Award was initiated in the summer of 1985 as a one-week, hands-on program for outstanding California high school science students. The program was developed and run by two past Summer Teacher Program participants hired specifically for this purpose. Each year since then, past Summer Teacher Program participants have been involved in the development and implementation of the program.

Participant Selection

Participants are selected primarily from candidates for the Lawrence Hall of Science's E.O. Lawrence Travel Award Program, which offers an outstanding high school student the opportunity to travel to Stockholm to attend the Nobel Prize awards ceremony. Candidates include state and regional science fair winners, finalists of the Westinghouse Talent Search and the Junior Science and Humanities Symposium, and International Chemistry and Physics Olympiad qualifiers. Candidates are also recommended by past participants of LBL's Summer Teacher Program. Students selected have the opportunity to invite a mentor teacher to accompany them to LBL and are encouraged to do so.

Both students and teachers receive round-trip travel expenses, housing, and meals while visiting LBL. Twenty-five participants attended the Science Week Award program in 1987.

Activities

Students and teachers are given tours, lectures, demonstrations, and an opportunity for hands-on experience with instrumentation used in the research laboratory. The program stresses direct small-group exposure to research and researchers. Topics covered have included DNA cloning and mapping, atmospheric aerosol research, scanning electron microscopy, the evidence for comet impact leading to the extinction of the dinosaurs, and many others.

Evaluation

At the end of the program, both students and teachers are asked to complete an evaluation form.

Comments from students reveal that they gain both inspiration and specific knowledge from the program:

* By seeing these great scientists at work, I get great incentive to delve deeper into science.

* Being able to talk to scientists furthered my interests and goals in science.

* This week will certainly influence my future career plans, as well as my education plans.

* I will use the motivation to go out and do what I want -- Mr. Seaborg and Mr. Ghiorso taught me that.

* I feel more at home now with science equipment and experiments.

* I definitely have a better understanding of atoms and their makeup.

* I will use my new knowledge of particle physics to better understand the fundamentals of chemistry and physics.

For teachers, too, the week at LBL is a learning experience. Many comment on obtaining information they will take back to the classroom:

* I will have more firsthand information to relay

to my students about frontline research.

* Most of the information (obtained at LBL) will be used in some way. Contacts developed will also be used for student research and information.

* Some of the best points of the program were the chance to view sophisticated research equipment and interact with other teachers and students. I will definitely include information from this visit in my curriculum.

Both students and teachers enjoy attending the program together and feel that they benefit from doing so:

* I have heard comments about how much fun it is to have students and teachers together.

* The program allows the student and teacher to discuss what was learned. Hence, the teacher better knows what material could be feasibly added to his or her curriculum. Also, the student can clarify anything he or she may not understand.

* Because we were treated as equals, we treated each other as equals.

* Often the teachers brought up some intriguing questions during discussions. (student comment)

Both students and teachers agree that hands-on activities are especially valuable, and many have commented that they would like even more. In response to this request, the 1988 program will include hands-on activities in research laboratories every afternoon.

3.4 High School Honors Program in the Life Sciences

History

The DOE High School Honors Programs were created in 1985 to provide some of the country's best science students with the opportunity to gain firsthand experience in advanced scientific research at the DOE national laboratories. In 1987, two-week Honors Programs were held at four national laboratories: Supercomputer Honors Program, Lawrence Livermore National Laboratory; Honors Research Program in Particle Physics, Fermi National Accelerator Laboratory; Honors Research Program at the National Synchrotron Light Source, Brookhaven National Laboratory; and Honors Program in the Life

Sciences, Lawrence Berkeley Laboratory. The LBL Honors Program was held for the first time in 1987.

Participant Selection

The students are chosen by the governors of the 50 states, the governor of Puerto Rico, and the mayor of the District of Columbia. In 1987, seven foreign countries were also invited to send students to one or more of the DOE Honors Programs. The 55 students in the LBL program included participants from Canada, England, and Japan.

In 1987, each governor or mayor selected four students, one for participation in each of the Honors Programs. The selection procedure varied from state to state. For example, some governors selected the state science fair winners, some ran an essay contest, and some asked teachers throughout the state to nominate students and appointed a committee to make the final selections.

Activities and Goals

Each morning, participants in the LBL Honors Program attended two lectures on current research topics in the life sciences. The lectures were followed by discussion. In the afternoon, the students were assigned to research laboratories in teams of four to six. Social and recreational activities -- including a barbecue picnic, an Oakland A's baseball game, a hike to the ocean at Point Reyes National Seashore, and visits to local science museums -- were scheduled for evenings and weekends.

The program was designed with the following objectives:

* 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 the environment.

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

* Offer the students hands-on experience with state-of-the-art instruments and techniques used in modern biology.

* Introduce students to some of the critical thinking

skills used in research in modern biology.

The laboratory assignments, scheduled for four hours each day, provided 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 analyze research results. Each team continued in a single laboratory assignment for the two weeks and completed a report at the end of the program. The laboratory assignments were as follows:

* Red blood cell transport
* Oxidative stress
* Radiobiology modeling
* Tissue culture manipulation
* Human DNA sequencing
* Genetics of photosynthesis
* Structure of DNA and protein
* Biological magnetic resonance
* DNA repair
* Carcinogenesis in mammary epithelial cells
* Antibodies and gene expression

Evaluation

Student reaction to the program was overwhelmingly positive. The following comments are from their final reports:

* I feel this is one of the most exhilarating experiences I have ever had.
* 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.
* I learned as much during these past two weeks as in

my entire final semester of high school.

* The 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.

* 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.

* 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 caused our interest in science to grow.

* The program has helped us immensely by giving us a taste of the excitement found in life sciences research.

Goodwin Liu, the California student, published a "yearbook" entitled LBL Legend and started a newsletter, the LBL Log, through which the Honors Program participants are keeping in touch.

3.5 Collaborative Programs with Lawrence Hall of Science

Science, Technology, and Education Evening

"Science, Technology, and Education Evening: A Program for Teachers of Science and Mathematics" was held on April 10, 1987, in recognition of National Science and Technology Week. Approximately 150 elementary and secondary school teachers attended the program, which included dinner discussion groups with LBL scientists, workshops at the Lawrence Hall of Science, tours of LBL, and a presentation by Yuan Lee, recipient of the 1986 Nobel Prize in Chemistry.

Participants selected their dinner discussion groups and LBL tours from the following:

Discussion groups:

* Advanced Light Source

* Air pollution and combustion chemistry

* Biology and medicine

* High energy physics
* Lasers and spectroscopy
* Medical research
* National Center for Electron Microscopy
* Nemesis and the supernova search
* Nuclear science
* Radon and indoor air quality
* Superconductivity

Tours:

* Bevatron
* SuperHILAC
* Nuclear and energy science laboratories

LBL/LHS/UCB Colloquium

"Updating Science Knowledge for Instruction" is a Colloquium jointly sponsored by LBL, LHS, and UC Berkeley. This program provides academic-year followup for teachers who have participated in REST, the LBL Summer Teacher Program, and LHS teacher programs, including Industry Initiatives for Science and Mathematics Education (IISME, an LHS/industry partnership program that provides teachers with summer employment in industry). The Colloquium promotes ongoing interaction among teachers who have participated in summer programs at LBL or in industry, provides teachers with new scientific knowledge, and encourages the transfer of this information to the classroom.

Each meeting includes a lecture, a formal discussion on how to translate the information presented into classroom instruction, and informal discussion during dinner. The meetings are held on selected Thursday evenings during the academic year.

The following are the dates and topics of the 1987-88 Colloquia:

* October 8, 1987:
  Updating Knowledge of Chemical Lasers

  Professor George Pimentel
  Department of Chemistry, UC Berkeley
  Lawrence Berkeley Laboratory

* December 3, 1987:
  Updating Knowledge of Carcinogens
  and Anticarcinogens

  Professor Bruce Ames
  Department of Biochemistry, UC Berkeley
  Lawrence Berkeley Laboratory

* February 4, 1988:
  Updating Knowledge of High Temperature Superconductors

  Professor Angelica Stacy
  Department of Chemistry, UC Berkeley
  Lawrence Berkeley Laboratory

* May 19, 1988:
  Updating Knowledge of the Brain

  Professor Marian Diamond
  Department of Physiology and Anatomy, UC Berkeley

National Chemistry Day

To celebrate National Chemistry Day on November 6, 1987, LBL, UC Berkeley, and the Lawrence Hall of Science cosponsored a program for middle and high school students and teachers. Over 300 participants heard chemist George Pimentel speak on "Opportunities in Chemistry," attended workshops at the Lawrence Hall of Science, and saw LBL's multimedia presentation.

The high school students and teachers were taken on small group tours of LBL or UCB chemistry laboratories. Each LBL group went on one or two of the following tours:

* How Chemists Study Dinosaur Extinction

* Organometallic Chemistry

* Spectroscopic Studies of Malformed Cells

* X-ray Crystallography of Complex Molecules

* Long-lived Radioactive Isotopes in the Environment

* Spectroscopic Methods to Study Atoms and Molecules

* Equipment Development for X-ray Analysis

* Use of the Magnetometer to Study Superconducting Materials

* Crystal Growing for Computer Applications

* The Search for Super Heavy Elements

* Production and Control of Acid Rain

* Aerogels: New Architectural Materials

* Combustion Chemistry

* The 88-Inch Cyclotron

* The Bevatron

* The SuperHILAC

The day ended with a career panel and reception at LBL for the middle school teachers and students, and a parallel program at UCB for the high school teachers and students. The LBL career panel was composed of the following chemists:

* Darleane Hoffman
  Professor of Chemistry, UC Berkeley
  Senior Scientist, LBL
  Nuclear and Radiochemistry

* Howard Hall
  Graduate Student, UC Berkeley
  Nuclear Chemistry and Radiochemistry

* Helen Michel
  Staff Scientist, LBL
  Archeological and Geological Dating

* Mark Alper
  Associate Director --
  Center for Advanced Materials, LBL
  Associate Division Head --
  Materials and Chemical Sciences Division, LBL
  Senior Lecturer in Biochemistry, UC Berkeley
  Biochemistry and Scientific Administration

High School Science Symposium

The LHS/LBL High School Science Symposium on Biotechnology and Genetic Engineering was held on December 12, 1987. The event, cosponsored by LHS and LBL, was developed and presented by the Biology Education Program at LHS. The symposium gave teams of high school students the opportunity to present information and recommendations about research and public policy issues related to biotechnology. Over 150 students and 40 teachers from 26 schools participated in the competition at LHS. The teams chose their presentation topics from the following:

* Human genome mapping
* Selection of genetic diseases for study
* Regulation of reproductive technologies
* Biological weapons
* Benefits and risks of genetically homogeneous crops
* Gene banks
* Patenting of genetically altered animals
* Breeding of herbicide-resistant food crops
* Is there a need for an International Center for Genetic Engineering and Biotechnology?
* Release of genetically engineered organisms
* Genetic counseling
* Voluntary versus mandatory genetic testing
* Use of reproductive technologies to save nearly extinct species
* Safety of biotechnology products and processes

Information on the symposium was sent to over 200 companies, colleges, organizations, and government officials. Over 50 percent responded by sending information to be used as resource materials for the student teams, and over 25 percent expressed willingness to serve as contacts for student interviews.

At the symposium, each team gave its half-hour presentation twice in the morning; each time, three judges scored

the presentation on content, style, and creativity. The four teams receiving the most points competed in the afternoon.

All participants received a certifcate, and the top three teams were awarded an all-day field trip to LBL. The names of the members of the first place team will be inscribed on a plaque to be on permanent display at LHS.

LBL life scientists served both as resource people prior to the competition and as judges on the day of the competition. In addition, staff from the LBL Precollege Education Programs and Public Information Department served as moderators and masters of ceremonies for the morning symposium sessions.

Public Science and Technology Education

The Public Science and Technology Education Program supports development, at LHS, of displays, exhibits, and discovery activities on major accomplishments in science and technology at LBL and the University of California, Berkeley. The purpose is to demonstrate to the public, particularly to youth, that science and engineering are central to meeting the nation's energy needs for the future. LHS, with more than 250,000 visitors each year, provides both an appropriate location for LBL displays and exhibits, and the opportunity to achieve our goal.

A cloud chamber, donated by LBL to the Lawrence Hall of Science, is currently being renovated for use in LHS public education programs in physics. LBL has also developed two displays for LHS: "The 1986 Nobel Prize in Chemistry" and "Applied Science Research at LBL." The Superconducting Super Collider Central Design Group and LHS are currently collaborating to develop an exhibit.

IV. MINORITY PROGRAMS

4.1 Introduction

The Lawrence Berkeley Laboratory's primary programs to further minority education in science are operated under a Memorandum of Understanding that establishes a Consortium comprising LBL, Jackson State University (JSU), and the Ana G. Mendez Educational Foundation (AGMEF). The Memorandum provides for the conduct of joint scientific research between the participating institutions, as well as strengthening of the academic and research capabilities of JSU and AGMEF. The Consortium has existed and operated since 1983; the Department of Energy has provided funding for its activities during the past two years (1986 and 1987).

The LBL/JSU/AGMEF Consortium is the first and, as of the close of FY 1987, continued to be the only such collaboration between a national laboratory, a black university, and an Hispanic university system. Fully consistent with its mission, LBL is supporting the development of the basic research and development capabilities of AGMEF and JSU. At the same time, JSU, an Historically Black College/University, is providing the major academic development program for AGMEF, an Hispanic university system.

In 1987, the Consortium's activities focused on the following areas:

* Faculty development
* Student development
* Precollege teacher development
* Collaborative research projects

4.2 History

Numerous national research studies have shown that minority youth -- black, American Indian, Mexican-American, and Puerto Rican students graduating from secondary schools on the mainland or in U.S. territorial possessions -- are

minimally prepared academically to pursue college-level mathematics and science. Those who do enroll in university courses typically perform at lower academic levels than their non-minority counterparts. In addition, minority students who attend predominantly minority universities and colleges must cope with the limited capacity of these institutions to offer academically diverse mathematics, natural science, and computer science curricula.

There are several reasons for the dilemma cited above. Minority institutions generally do not have a broad array of scientific or applied research equipment. Many of the faculty have not had substantial research opportunities; others have not yet earned doctoral degrees. Consequently, this limits graduate-level programs in the sciences at minority institutions. Indeed, many minority colleges lack strong basic undergraduate mathematics and science programs. Thus, these institutions are poorly equipped to provide the enriched academics or academic support systems needed to help a typical minority student succeed in the sciences. Ultimately, these conditions are the barriers that inhibit full participation of minority institutions in the mission and programs of federal agencies such as the Department of Energy, National Institutes of Health, NASA, and others.

As early 1978, LBL began a program to increase the involvement of scientists and researchers at minority institutions in the scientific programs that contribute to the Department of Energy's mission. After a number of formal and informal meetings over a two-year period, LBL and DOE sponsored a "Conference on Energy Research at Historically Black Universities." Sixty participants represented nineteen historically black institutions, five national laboratories, DOE, and two majority institutions. The conference proceedings document well the objectives, research group projects, and summary recommendations. Of particular interest here is the recommendation that cooperative programs be developed between the national laboratories and historically black colleges and universities.

In 1981, the first milestone was reached toward implementing that recommendation. With the stated goal of enhancing the "computer sciences and scientific research programs at both institutions, and...strengthening LBL's minority recruitment program," a Memorandum of Understanding establishing a joint, cooperative program between Jackson State University and Lawrence Berkeley Laboratory was signed.

A striking outgrowth of the JSU-LBL collaboration was the September 1983 agreement between LBL, Jackson State University, and the Ana G. Mendez Educational Foundation and its affiliate institutions (Puerto Rico Junior College, Metropoli-

tan University and University of Turabo). This formal Memorandum of Understanding joined AGMEF, JSU, and LBL in a consortium designed to advance the science and technology programs of JSU and AGMEF. The goal of this alliance is basic and direct: to develop and effect a long-term, comprehensive program that will enable the campuses of the Mendez Foundation and Jackson State University to provide a broad, quality offering in the natural and computer sciences, to increase the number of minority students entering these fields, and to contribute to scientific knowledge and the federal government's science mission through research.

Both Jackson State University and the three campuses of the Mendez Foundation education system have entered into this collaborative effort in pursuit of common goals: (1) provide campus faculty with improved research opportunities, (2) provide campus faculty with improved research seminars, (3) improve the academic support system provided to enrolled minority students, (4) develop strong undergraduate and graduate programs in mathematics, computer science, natural science, general science, technology, engineering, and other math-based disciplines, (5) develop precollege programs that better prepare minority students for a college program, (6) increase the number of graduates from math-based programs, and (7) develop an institutional capability to engage in competitive research and academics.

4.3 Faculty Development

The Summer Faculty Program

The Summer Faculty Program is one of the primary ways that LBL supports faculty development at JSU and AGMEF. This program has created the basis for peer relationships between researchers at JSU, AGMEF, and LBL.

Since the summer of 1984, faculty from the three AGMEF schools have had the opportunity to spend approximately two months each summer at LBL to gain exposure to current research and research methodology in their fields. The interests and experience of the faculty are matched with ongoing research projects at LBL.

During the summer of 1987, eight AGMEF faculty worked for approximately ten weeks at LBL on various projects. Two of the faculty worked in the LBL Applied Sciences Division, two in the Biology and Medicine Division, one in Computer Science, one in Earth Sciences, and one in the Mathematics Group of the Physics Division.

As with the LBL/AGMEF program, JSU faculty work at LBL to gain exposure to current research methodology in their fields. Seven JSU faculty came to LBL in the summer of 1987 for approximately ten weeks.

The summer program with JSU has, perhaps, placed a greater emphasis on developing cooperative research programs. These programs are described in Section 4.6.

4.4 Student Development

In support of the student development efforts of JSU and AGMEF, two programs are conducted at LBL: the Semester Cooperative Program, and the Summer Internship Program.

Semester Cooperative Program

Under the LBL/JSU Semester Cooperative Program, students from Jackson State come to LBL for a full academic semester to work with LBL staff scientists. The program is offered to a limited number of students who meet stated eligibility requirements and who are majoring in a biological or physical science, mathematics, computer science, or engineering. Students are selected on the basis of their academic standing, faculty recommendations, and interviews conducted by LBL scientific staff.

The Semester Cooperative Program is designed to be as complete an academic/research experience as possible. Participating students are assigned to work for LBL staff scientists who assign their day-to-day work and long-term projects. Four students participated during the Fall 1986 Semester, and six participated during the Spring 1987 Semester.

An agreement with the University of California, Berkeley, enables the students to enroll in courses on the UC campus. This has been especially useful in the case of courses that are not available at the student's home campus.

Summer Internship Program

Students from JSU and the three AGMEF schools participate in the LBL Summer Internship Program. As with the Semester Cooperative program, summer internships are offered to a limited number of students who meet stated eligibility

requirements and who are majoring in a biological or physical science, mathematics, computer science, or engineering. Students are selected on the basis of their academic standing, faculty recommendations, and interviews conducted by LBL scientific staff.

Participating students work for LBL staff scientists who assign their day-to-day work and summer projects. The bulk of the students' time is spent in the research laboratories. However, additional assignments and events round out the program:

* Tours of LBL and LLNL expose students to the wide range of scientific research being carried out today and to state-of-the-art scientific and computer equipment.

* Early in the program, students write short statements of their research goals for the summer. In this way, they are able to quickly focus on the work that they will be performing. By meeting with CSEE staff and fellow students, the students are provided with a further opportunity to articulate their work and goals.

* Toward the end of the program, the students complete a paper on their summer work. In addition to writing the papers, they present their work at a seminar of their peers and scientific sponsors.

* Along with participants in the Summer Teacher Program and the Laboratory Co-op Program, the Summer Internship participants attend the LBL Summer Lecture Series.

Twenty students participated in the 1987 Summer Internship Program. Nine of the students were from AGMEF universities; eleven were from Jackson State. Of the twenty, three worked in Computer Science (either in the LBL Computer Science Division or the Real Time Systems Group of the Engineering Division), nine in the Biology and Medicine Division, five in the Applied Sciences Division, one in the Engineering Division, and one in the Physics Division.

Evaluation

Both student participants and their LBL supervisors are asked to provide written evaluations of the student programs. The following comments typify the students' responses:

* The experience was wonderful. I had no idea that I would learn as much as I did.

* I was very satisfied with the assignment I was given. Not only did I get exposure to new software as I had hoped, but I also got a chance to be in an environment in which I could pick up on different aspects of the computer science field.

* I came here looking for a challenge, a great experience, and a great research opportunity. I received all this and more on the aerogel project.

* I would suggest that every individual, if given an opportunity, should come to LBL and work at least for one semester to gain a new kind of experience.

The supervising scientists are equally positive about the programs. Their comments indicate that the students both perform well in the laboratory and gain personally from the experience:

* He is an alert and inquisitive person who can be trusted to take on responsibilities. I feel that he is just beginning to realize his own potential and has expanded his horizons from his experience in our laboratory and in the university environment at Berkeley.

* Her work has proven very valuable to the bio-medical researchers at the Bevatron, as well as to the computer scientists here. She will leave behind well-documented and well-structured programs.

* She brings to all challenges considerable ability and a high degree of motivation. I was particularly pleased that she seized on every opportunity to learn as much as possible.

* He had a great intuitive sense about how to work properly in a laboratory. He followed directions well, paid attention to appropriate details, and seemed to ask questions at just the correct time.

4.5 Precollege Teacher Development

The LBL Summer Teacher Program, described in Section 3.2, is a six-week program that includes outstanding secondary school teachers recruited both nationally and in the San

Francisco Bay Area, as well as outstanding minority teachers from Mississippi and Puerto Rico. The participating teachers are assigned to research groups that match their interests, educational background, and current teaching responsibilities. Placing teachers in the research laboratory as active participants creates a unique challenge and opportunity for them to see another dimension to science and scientists. Approximately 80 percent of the time is spent in the research laboratory; 20 percent is spent in lectures, seminars, and tours.

Minority teachers who teach predominantly minority students are recruited through the LBL/JSU/AGMEF relationship. In 1987, participants included three teachers from the Holmes County (Mississippi) School District and one from the Puerto Rico Department of Education.

Evaluation

Teachers sponsored by the minority education programs complete the same evaluation form as other participants in the Summer Teacher Program. Their comments indicate that the program is a significant milestone in their professional development:

* My experience at LBL will allow me to be a more effective and better teacher. I have new experiences to share with my students and co-workers.

* I learned new techniques and scientific procedures that I had never used before. As a human being, I have gained more than words can say...

* My experience here will enhance my teaching skills in my classroom discussions and in my laboratory, because I have acquired so much knowledge. I will be a better teacher this term -- I'm sure of it.

4.6 Collaborative Research Projects

Since 1985, when the first LBL/JSU collaborative research projects were initiated, there have been numerous meetings between LBL scientists and JSU faculty in attempts to define these scientific relationships. The arrangements that have evolved are formed on the basis of "equal partners" in research rather than paternalistic relationships.

A major factor that contributes to the peer relationship

between the JSU researchers and LBL scientists is the annual Research Conference held on the JSU campus during the Spring Semester each year. During the conference held in April 1987, LBL scientists and JSU professors made presentations and discussed research concepts for future joint proposals.

The following are examples of joint LBL/JSU research projects:

"Effect of Radiation on Cells"	Dr. Balwant Sekhon	JSU
	Dr. Wen-Hsun Yang	JSU
	Dr. Aloke Chatterjee	LBL
"NMR Carbon Fixation Studies"	Dr. Richard Sullivan	JSU
	Dr. Rolf Melhorn	LBL
"Building Energy Analysis"	Dr. Sonny Bolls	JSU
	Dr. Ron Ritschard	LBL
"Characterization of Ambient Carbonaceous Aerosols in Southeastern United States"	Dr. Cass Parker	JSU
	Dr. Ray Dod	LBL
	Dr. Tihomir Novakov	LBL
"Chick Tendon Proteoglycans"	Dr. Denise Chan	JSU
	Dr. Mina Bissell	LBL
"Energy-Conserving Moisture Mitigation Studies"	Dr. Sonny Bolls	JSU
	Dr. Mark Modera	LBL

The first collaborative research project of LBL and AGMEF scientists is an atmospheric science study involving faculty from Metropolitan University. As part of a worldwide study, the Metropolitan faculty are determining levels and movement of pollutants in Puerto Rico. This should result in several publications.

V. FUNDING

The table below summarizes the sources and amounts of funding in FY 1987 for the programs of LBL's Center for Science and Engineering Education. Administrative staff costs for the Precollege Education Programs were covered by the Lawrence Berkeley Laboratory, and research staff time was covered by research grant funds.

PROGRAM	FUNDING SOURCE	AMOUNT ($K)
Lab Co-op	DOE (Lab Co-op)	125.0
Summer Teacher	DOE (Precollege)	20.0
	Albany School District	.2
	DOE (JSU/AGMEF)	36.9
REST	DOE (Precollege)	20.0
Science Week Award	DOE (Precollege)	20.0
High School Honors	DOE (HSH)	120.0
JSU Co-op	DOE (JSU/AGMEF)	66.1
JSU Faculty	DOE (JSU/AGMEF)	75.6
JSU Summer Students	DOE (JSU/AGMEF)	80.9
AGMEF Co-op	DOE (JSU/AGMEF)	23.4
AGMEF Faculty	DOE (JSU/AGMEF)	93.9
AGMEF Summer Students	DOE (JSU/AGMEF)	59.7
JSU/AGMEF General and Professional Support	DOE (JSU/AGMEF)	132.3
	Total:	874.0

VI. FUTURE PLANS

The Department of Energy has a growing commitment to education, and it is expected that the LBL Center for Science and Engineering Education will continue to expand its activities in response to this DOE commitment. Integration of the minority education programs with other CSEE activities will continue. Research participation programs will be developed for science and engineering faculty from California's community colleges and from small colleges and universities, and support for these programs will be sought. Currently, a large part of CSEE funding is devoted to the undergraduate programs, which provide research participation opportunities for outstanding science and engineering students who have completed their sophomore year of college. This area will continue to grow, with increases in SERS participants and the addition of positions for students funded through the Associated Western Universities to complement continued appointments under Lab Co-op and JSU/AGMEF funding.

Minority education programs sponsored by the Consortium of LBL, JSU, and AGMEF will remain a cornerstone of the Center. Collaborative research efforts will continue, as will student, faculty and precollege teacher development programs. Increased support will be given to research development workshops, with the goal of identifying and exploring specific research projects that can be conducted jointly by two of the institutions, or even by all three. Precollege teachers attending the LBL Summer Teacher Program under Consortium sponsorship will join curriculum development efforts of LBL and the Lawrence Hall of Science, and will use the new instructional materials at their home schools.

CSEE's activities at the preuniversity level are expected to increase significantly in FY 1989. The focus of these activities will be expanded opportunities for research participation by middle school and high school teachers through REST and the Summer Teacher Program. New sources of funding will include an enlarged REST Program. The California Outreach Program, to be initiated in FY 1988, will encourage and assist qualified teachers to raise funds in their own communities for their Summer Teacher Program positions. Providing research and development exposure to committed and talented students will remain an important dimension of the Precollege Programs, and the High School Honors Program will remain central to this effort.

The partnership between Lawrence Berkeley Laboratory and the Lawrence Hall of Science will continue to grow. Highly successful joint programs -- such as the Colloquium, Updating Science Knowledge for Instruction -- will continue to be supported and in some cases be expanded. The High School Science Symposium will be expanded into a statewide program. An important mission of the Lawrence Hall of Science is to promote public understanding of science and technology. This mission is accomplished in part through exhibit programs. Through CSEE, LBL will continue to collaborate with LHS to develop and plan exhibits featuring breakthroughs in science and technology developed under DOE funding.

Also in cooperation with LHS, the LBL Center for Science and Engineering Education plans to engage in curriculum development programs with a focus on interdisciplinary energy science and associated societal issues. The programs will develop hands-on experiments and demonstrations, with an emphasis on materials for the secondary school level. The science and technology basis for the experiments, demonstrations, and other curriculum materials will be drawn from research projects at LBL.

A partnership between the Lawrence Hall of Science and the DOE national laboratories is already forming to carry out materials development, testing, and dissemination, as well as teacher training, at a national level. Currently, LHS, Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, and Oak Ridge Associated Universities are collaborating on a curriculum development project entitled Greenhouse Gases and Global Climate Change.

Teachers working in the national laboratory environment are a significant resource for the genesis of new and revised materials for high school and middle school classrooms. To develop and pilot curricular materials on molecular biology and genetic engineering, LBL and LHS are initiating a partnership that will begin activity in the summer of 1988 and include Pacific Northwest Laboratory, San Francisco State University, and the University of California at Davis. Cooperative efforts with other DOE national laboratories will continue to be sought and strengthened.

VII. CONCLUSION

In 1987, LBL reached many significant milestones in its efforts to develop a comprehensive set of multilevel educational programs: the Center for Science and Engineering Education was established to coordinate and strengthen existing precollege, undergraduate, and minority education programs; the Science and Engineering Research Semester Program was initiated; and a partnership was established with the Lawrence Hall of Science to develop joint education programs. As the Center grows, research participation opportunities for precollege and college instructors and students will be expanded, and new partnerships will be initiated between LBL and the education community.

Precollege teachers carry a great responsibility for encouraging and guiding their students into careers in science. The nature of research at the national laboratories, whether basic or applied, is usually both innovative and long-range and thus gives teachers a peek into the future -- the same future in which their students, inspired by quality science teaching in their early years, will make their contributions. Unfortunately, we can not provide every science and mathematics teacher with a research participation experience. Soon, however, as a result of curriculum development partnerships between DOE national laboratories and educational institutions, innovative materials on state-of-the-art science will be available to teachers nationwide.

The success of programs sponsored by LBL's Center for Science and Engineering Education makes it clear that LBL and other national laboratories should not only participate in educational enrichment efforts, but should also take a leadership role in educational reform and in establishing a much-needed link between state-of-the-art scientific research and precollege, undergraduate, and minority education.

ACKNOWLEDGEMENTS

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James Bartholomew
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Jacob Bastacky
Gloria Bayne
Paul Berdahl
Mina Bissell
Harvey Blanch
Jerry Borges
Edith Bourret
Susan Brady
George Brecher
Theresa Breckon
Nancy Brown
Thomas Budinger
Melvin Calvin
S.G. Chang
Michael Chartock
Aloke Chatterjee
Douglas Clark
David Cleveland
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Michael Collier
Stephen Compton
Paul Concus
Priscilla Cooper
Carroll Coughlin
William Creager
Michael Crommie
Janis Dairiki
Joan Daisey
Ray Dod
Shirley Ebbe
Reid Edwards
Lewis Feldman
Richard Fish
Heather Freeman
Albert Ghiorso
Judith Goldhaber
Kenneth Gregorich
Lara Gundel
Tetsuo Hadeishi
James Haley
Howard Hall
John Hearst
Sheri Henderson
Michael Hilton
Darleane Hoffman
William Holley
Donald Hollister
Junko Hosoda
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Marjorie Hutchinson
Joseph Jaklevic
Michael Jayko
Robert Johnson
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Don Landis
Steven Leadon
Claudette Lederer
Yuan Lee
Helen Leung
Robert Leven
Jay Levy
David Littlejohn
Kevin Lofftus
Fred Lothrop
Larry Lowery
Bertram Lubin
Donald Lucas
Robert Macey
Ronald Madaras
Marcos Maestre
Frances Mann
Samuel Markowitz
Richard Martin
Howard Matis
Eileen Mattox
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Ralph McLaughlin
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Katharine Metropolis
Helen Michel
Jacques Millaud
Kathleen Miller
Mark Modera
Robert Morris
Alex Nichols
Heino Nitsche
Michael Nitschke
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Tihomir Novakov
Grazyna Odyniec
Patricia Olson
Lester Packer
Rebecca Palmer
Gordon Parry
Carlton Pennypacker
Patricia Powers-Risius
Jorgen Randrup
Ronald Ritschard
Adrian Rodriguez
Ruth Roots
Gerd Rosenblatt
Peter Schultz
Richard Schwarz
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Paul Silverman
Angela Smothers
Gabor Somorjai
Martha Stampfer
Gunther Stent
David Stevens
Andrew Stoker
Barbara Storms
Leslie Sykes
Thomas Tenforde
Edward Theil
Allan Tischler
Arthur Tressler
Marlene Ware
Eicke Weber
David Wemmer
Oleh Weres
Gordon Wozniak
Tracey Yang
Lynn Yarris
Andrew Yee
Allan Zalkin
Alex Zettl

APPENDIX A: Staff

Margaret S. Carlock, REST Coordinator and Precollege Education Program Development Administrator, holds an A.B. in biochemistry from the University of California at Berkeley. She is Science Department Chair at Albany High School, Albany, California, and has been an instructor in the U.C. Berkeley Summer Program for Educators. Her many honors as a science educator include 1985 and 1986 State Awardee Plaques for the Presidential Award for Excellence in Science and Mathematics Teaching, and inclusion on the National Association of Science-Technology Centers 1986 Honor Roll for Teachers.

Susan Cristancho, Coordinator of the Summer Teacher Program, received her A.B. in bacteriology/immunology at the University of California at Berkeley. She has been teaching science for nine years. For the past five years, she has been Science Department Chair at Claremont Middle School in Oakland, California, where she teaches seventh grade general science. She has also been a researcher in immunology at U.C. Berkeley; her work involved isolating and studying a bacterium to improve the Mishell/Dutton immunoassay test.

Lucille Day, Director of LBL Precollege Education Programs, completed graduate studies at the University of California at Berkeley: she earned a Ph.D. in science and mathematics education and an M.A. in zoology with specialization in cell and developmental biology. Her experience in science education includes research, curriculum development, in-service teacher training, and elementary-through-college teaching. She is a coauthor of How to Encourage Girls in Math and Science: Strategies for Parents and Educators (Prentice-Hall, 1982; Dale Seymour Publications, 1986).

Laurel Egenberger, Director of Undergraduate Education Programs and Coordinator for Education Programs of the LBL/JSU/AGMEF Consortium, received her B.A. and M.A. degrees in history. She also holds a Secondary Teaching Credential and has community college teaching experience.

Martha Krebs, Acting Director of the LBL Center for Science and Engineering Education and Associate Laboratory Director for Planning and Development, received her Ph.D. in physics from Catholic University of America in Washington, D.C. She has been a policy analyst in the Science Policy Research Division of the Congressional Research Service and Staff Director of the Energy Development and Applications Subcommittee of the House Committee on Science and Technology.

Roland J. Otto, Assistant Director of the Lawrence Hall of Science, University of California at Berkeley, and staff

scientist at LBL (on leave of absence), received his Ph.D. in nuclear chemistry from Purdue University. His research and management experience encompasses nuclear chemistry, energy storage, and environmental chemistry. He is past Director of the LBL Precollege Education Programs and is currently Principal Investigator for the Lab Co-op Program, the Center for Science and Engineering Education, and the Precollege Education Programs, including REST.

Alexandre Quintanilha, High School Honors Program Coordinator, holds a Ph.D. in physics from the University of Witwatersrand. He is currently Adjunct Associate Professor of Physiology at U.C., Berkeley, an LBL Staff Scientist, Assistant Head of LBL's Applied Science Division, and Director of LBL's Center for Atmospheric and Biospheric Effects of Combustion. His areas of research interest include environmental issues, the physiology of oxygen toxicity, noninvasive techniques in biotechnology, and the pathophysiology of sickle cell disease.

Janet Smith, High School Honors Program Coordinator and past Director of Undergraduate Education Programs, received her A.B. in sociology from the University of California at Berkeley and did graduate work in industrial relations. She is currently a Personnel Administrator with LBL's Applied Science Division. Through 1987, she chaired the Laboratory Co-op Committee and held administrative responsibility for the Laboratory Co-op Program and the Science and Engineering Research Semester.

Laboratory Co-op Program Steering Committee

Frank Asaro
Gloria Bayne
Janis Dairiki
Francis Mann
Eileen Mattox
Ralph McLaughlin
Eric Norman
Janet Smith
Thomas Tenforde

APPENDIX B:

Summer Lecture Series Topics

1987 Titles:

Light, Neutrinos, and Matter from Supernova Explosions
Dr. Carl Pennypacker

Molecular Beam Studies on Chemical Reaction Dynamics
Prof. Yuan T. Lee

Indoor Radon: Occurrence, Risk, and Control
Dr. Richard Sextro

Recent Developments in High Temperature Superconductors
Prof. Alex Zettl

Why Sequence the Human Genome?
Dr. Paul Silverman

1986 Titles:

Electrochemical Energy in Our Future
Dr. Elton Cairns

Understanding Chemical Reaction Dynamics:
A Laboratory Laser Light Show
Dr. Brad Moore

Fractal Analysis in Physics and Chemistry
Dr. Shayne Johnston

From the Cyclotron to the SSC:
High Energy Physics Today
Dr. David Jackson

In Search of Quark Matter
Dr. Lee Schroeder

1985 Titles:

Energy Efficient Buildings
Dr. Art Rosenfeld

Research in Biology and Medicine
Dr. Edward Alpen

Industrial Haze Over the Polar Ice Cap:
A New Term in the Climate Equation
Dr. Hal Rosen

Chemical Education: A World Perspective
Dr. Marjorie Gardner

Dinosaurs, Comet Storms, and Nemesis
Dr. Richard Muller

APPENDIX C:

Participants in Laboratory Co-op Program, 1987

Summer Program

NAME	SCHOOL	LBL DIVISION
Baruch, Amy	Bryn Mawr	Mat. & Chem. Sci.
Busing, Darren	UC Berkeley	Computer Sci.
Chan, Johnson	UC Davis	Chem. Bio.
Fortune, Katherine	Emory Univ.	Nuclear Sci.
Ghanadan, Reza	Univ. of Maryland	Nuclear Sci.
Horch, Elliott	Univ. of Chicago	Nuclear Sci.
Johnson, Pia	UC Davis	Bio. & Med.
Knop, Robert	Harvey Mudd	Nuclear Sci.
Lee, Daniel	Harvard	Applied Sci.
Longuemare, Maria	Georgetown Univ.	Applied Sci.
Patel, Rita	UC San Diego	Applied Sci.
Robinson, Merle	Cooper Union	Nuclear Sci.
Wang, Jeanlynn	UC Berkeley	Applied Sci.

Academic Year Program

NAME	SCHOOL	LBL DIVISION
Jiao, Hong	UC Berkeley	Applied Sci.
Lee, Anna	UC Berkeley	Applied Sci.
Liu, James	UC Berkeley	Nuclear Sci.
Pieper, Patrick	UC Berkeley	Bio. & Med.

APPENDIX D:

Participants in SERS, 1987

NAME	SCHOOL	LBL DIVISION
Ashworth, Michael	S.D. School of Mines and Technology	Nuclear Sci.
Goode, Gayla	Dillard Univ.	Applied Sci.
H.-Despointes, Beatrice	Louisiana State Univ.	Bio. & Med.
Levine, Timothy	Univ. of Maryland	Mat. & Chem. Sci.
Sisk, Ellen	Evergreen State Coll.	Bio. & Med.
Svoboda, Karl	Cornell Univ.	Physics
Varos, Richard Jr.	Geneva College	Engineering

APPENDIX E:

Participants in Summer Teacher Program, 1987

Dean, Larry
Chemistry, Computers
De La Salle High School
Concord, CA

Hubbard, Donald
Physics, Chemistry
Berkeley High School
Berkeley, CA

Jones, Florence Louise
Biology
J.J. McClain High School
Lexington, MS

Joyce, James Freddie
Biology
S.F.V. Marshall High School
Tehula, MS

Lohman, Rich
Gen. Sci., Electronics, Math
Albany High School
Albany, CA

Rebensdorf, Alan
Chemistry, Math
Encinal High School
Alameda, CA

Richmond, Lynden
Biology
King Estates Junior High
Oakland, CA

Thiele, Maria
Biology, Res. Methods
John F. Kennedy High
Santa Isabel, PR

Thomas, Melba
Biology
J.J. McClain High School
Lexington, MS

APPENDIX F:

Participants in REST, 1987

Biggs, Alton (ORNL)
Allen, TX

Dorsey, Brenda (PNL)
Elmhurst, IL

Escudero, Edmund (LBL)
Cincinnati, OH

Galbraith, Richard (ORNL)
Bryant, AR

Johnson, Allene (LBL)
Summit, NJ

Klappier, Robert (ANL)
Wheaton, IL

Neuman, John (LLNL)
Hillsboro, OR

APPENDIX G:

Participants in Science Week Award, 1987

Student Participants:

Ashidina, Kelly
Watsonville, CA

Carter, Steven
Eureka, CA

Chen, Richard
Albany, CA

Cobeen, Gratia
Gridley, CA

David, Jesse
San Rafael, CA

Gong, Kevin
El Cerrito, CA

Holt, Gary
Bell Canyon, CA

Hou, Lisa
Monterey Park, CA

Jacobson, Andrew
Orinda, CA

Lee, Lawrance
San Francisco, CA

Mar, Kelvin
Monterey Park, CA

Moon, Sung-Yil
Richmond, CA

Mullarkey, Markus
Albany, CA

Ryder, Scott
Fresno, CA

Smith, Melissa
Salinas, CA

Tran, David
Davis, CA

Truong, Vince
Alhambra, CA

Teacher Participants:

Arnold, Jack
Pebble Beach, CA

Becker, Urban
San Francisco, CA

Carlock, Peggy
El Sobrante, CA

Freiler, David
Gridley, CA

Hiatt, Tucker
Corte Madera, CA

Huff, Brad
Fresno, CA

Morgan, Roger
Watsonville, CA

Nichols, G. Duane
Walnut, CA

APPENDIX H:

Participants in Minority Programs, 1987

TABLE 1. LBL/JSU/AGMEF 1987 SUMMER FACULTY PROGRAMS, AGMEF FACULTY

Visiting Faculty	LBL Collaborator	Division	Research Area
Denis del Toro	M. Bissell	Biology & Medicine	Biological studies
Fernando Diaz	T. Novakov	Applied Science	Atmospheric aerosol sampling. (As part of this work, a proposal has been submitted to NSF for a joint, collaborative research project to establish a sampling station at the El Yunque Rain Forest.)
Edgardo Garcia	W. Johnston	Information & Computing Sciences	Computer Sciences
Margarita Irizary	A. Chatterjee	Biology & Medicine	Radiation damage to DNA.
Guillermo Martinez	A. Yee	Earth Sciences	Instrumentation Analysis
Leida Menendez	P. Powers-Risius	Biology & Medicine	Heavy Ion Radiology
Carmen Reveron	L. Packer	Applied Sciences	Biochemistry and Physiology of Cyanobacteria
Jorge Sarmiento	P. Concus	Physics (Math)	Analysis of Strongly Regular Graphs

TABLE 2. LBL/JSU/AGMEF 1987 SUMMER FACULTY PROGRAMS, JACKSON STATE UNIVERSITY

Visiting Faculty	LBL Collaborator	Division	Research Area
Shayne Johnston	A. Sessler	Physics	Sideband Control in Free-Electron Laser Amplifiers.
Bela Karvaly	G. Somorjai	Materials & Chemical Sciences	Organic and Polymeric Semiconductors.
Watson Lawrence	W. Johnston	Information & Computer Sciences	Computer Sciences.
Billy Lim	W. Bagot	Administration	Data Processing.
Baldev Raj	J. Bartholomew	Chemical Biodynamics	Tissue Specific Expression of Ri T-DNA in Nicotania Tabacum.
Sunita Rana	M. Hutchinson	Information & Computer Sciences	Application of Computer Techniques to catalogue and analyze genealogy of viral genes.
Wen-Hsun Yang	A. Chatterjee	Biology & Medicine	Radiation effect on SV-40 Viral DNA.

TABLE 3. 1986 FALL SEMESTER CO-OPERATIVE PROGRAM PARTICIPANTS

Student	Research Sponsor	Division	Research Area
Jimmie Jones	N. Brown	Applied Science	Combustions Studies of Nitrous Oxide.
Theaortres McGee	A. Rodriguez	Biology & Medicine	Late Effects of Ionizing Radiation on Normal Tissues.
Stephanie Thames	J. Ainsworth	Biology & Medicine	Radiation and Life Shortening Effects
Kenneth West	E. Close	Information & Computer Sciences	Interface of SPSSx and Tell-A-Graf.

TABLE 4. 1987 SPRING SEMESTER CO-OPERATIVE PROGRAM PARTICIPANT

Student	Research Sponsor	Division	Research Area
Gurvinder Ahluwalia	M. Hutchinson	Information & Computing Sciences	Implementing Remote Procedure Calls for Providing a User Interface to a Video Animation System.
Tracy Brent	C. Lederer	Information & Computing Sciences	Tell-A-Graf
Pendyala Haranath	D. Cleveland	Information & Computing Sciences	On-Line Accelerator Pool Inventory.
Freddie Harrington	P. Powers-Risius	Biology & Medicine	Effects of Radiation on Normal Tissue.
Mae Frances Hibbler	A. Hunt	Applied Sciences	Silica Aerogels
Shriharsh Pole	J. Afzal	Biology & Medicine	Effect of Immunotherapy on Irradiated Rat Rhabdomyosarcoma

TABLE 5. LBL/JSU/AGMEF 1987 SUMMER STUDENT INTERNSHIP PROGRAM PARTICIPANTS FROM AGMEF CAMPUSES

Students	Sponsors	LBL Division	Research Area
Sandra Aponte	M. Collier/ S. Henderson	Biology & Medicine	Radiotherapy Treatment Planning.
Edwin Perez Feliciano	J. Borges	Information & Computing Sciences	Interface Between Focus & Tell-A-Graf.
Deborah Rivera Torres	T. Novakov	Applied Sciences	Puerto Rico Aerosal Sampling
Jorge Rosario Paris	J. Ainsworth	Biology & Medicine	Radiation Effects
Lourdes Valentin	A. Chatterjee	Biology & Medicine	Radiation Damage to SV 40 DNA in Aqueaus Solution
Mariano Acosta Cruz	T. Yang	Biology & Medicine	Effects of a Combination of X-Rays and the Restriction Endonuclease ECOR I on CHO Cells and Rat II Cells
Antonio Nieves Rivera	T. Yang	Biology & Medicine	Combination Effect of Radiation and Restricted Enzyme on Rat-2 and CHO Cells
Jannette O'Neill Gonzalez	S. Ebbe	Biology & Medicine	Platelet Survial Using the Chromium-51 Labeling Technique
Wanda Reyes Coraliz	T. Novakov	Applied Sciences	Atmospheric Aerosol Chemical Sampling

TABLE 6. LBL/JSU/AGMEF 1987 SUMMER STUDENT INTERNSHIP PROGRAM PARTICIPANTS FROM JACKSON STATE

Students	Sponsors	LBL Division	Research Area
Gurvinder Ahluwalia	M. Hutchinson	Information & Computing Sciences Division	Implementation of TCP Based Remote Procedure Cells for a Video Animation System
David Griffith	J. Millaud	Engineering	Manipulation and Simulation on the Hewlett-Packard Engineering Graphics System
Raerlisha Foster	R. Madaras	Physics	The DO EC-EM Calorimeter Project
Frances Hibbler	A. Hunt	Applied Science	Aerosel Gels
Jimmie Jones	N. Brown	Applied Science	Research Procedures of Nitrous Oxide Produced and Destroyed During Combustion
Shriharsh Pole	J. Afzal	Biology & Medicine	Combination of Radiotherapy and Immunotherapy on Rat Rhabdomyosarcoma
Doris Tribune	M. Bissell	Biology & Medicine	Analysis of the Interactions Between ROUS Sarcoma Virus and Chick Embryo Cells in Culture
Denise Weeks	J. Afzal	Biology & Medicine	Tumor Radiobiology
Kenneth West	E. Close	Information & Computing Sciences Division	The Automation of the Interface of SPSSx and Tell-A-Graff
Tina Williams	N. Brown	Applied Sciences	Modeling Study of Nitrous Oxide Production and Destruction During Combustion
Jian-Ping Yang	T. Breckon	Engineering	Communication links between VAX-11/760 and Modcomp IV/II computers

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