COLD SPRING HARBOR CURRICULUM STUDY

Genetic engineering, recombinant DNA, cloning, and gene splicing are buzzwords for the DNA revolution that has brought scientists to the very brink of understanding the molecular basis of life. Upon this explicit knowledge is based a burgeoning biotechnology industry which, like the explosive growth of computer technology, promises to profoundly influence American culture.

Although the DNA revolution has been science fact for more than a decade, to the general public it still largely belongs to the realm of science fiction. Adequate knowledge of DNA science has not filtered far beyond the doors of academia. This state of public ignorance threatens the nation's ability to make informed policy decisions about issues generated by biotechnical enterprise.

Time to Clean a Cluttered Closet

Most critical, there has not yet been a coordinated effort nor national commitment to update science teaching to take into account the recent, dramatic developments in biological science. We are in the infancy of a scientific revolution of monumental proportions, but our children don't know it. We are failing miserably to prepare young people for the technological world they must inhabit.

Accumulated in the closet of science teaching are anachronistic concepts and methods that bear little relevance to the real science of discovery. At a time when biologists are on the verge of understanding cancer and engineering plants to quell world hunger, biology students are required to memorize terms and definitions of an historical science no longer practiced at the lab bench.

Peering into a closet cluttered with the accumulated minutiae of bygone days, one can understand why science teaching fails to capture the excitement of modern biology. It is time to sweep clean the closet of earthworm anatomy and frog physiology to make room for gene therapy and molecular engineering.

Addressing the Problems of Science Education

The Cold Spring Harbor Curriculum Study was initiated in January 1985 to bridge the gap between science and society, and to bring modern molecular biology down to a level appropriate for precollege and freshman college students. Its goal is to design novel teaching materials and to train teachers in their use.

The program directly addresses the major problems associated with integrating up-to-date ideas into science courses at the precollege and freshman college level: 1) outdated syllabi, 2) lack of teacher retraining programs, 3) lack of teacher motivation, 4) lack of interactive and lab-oriented teaching materials, and 5) lack of modern lab equipment. By affecting change at the top of the education pyramid—at the level of board members, administrators, science chairpersons, teachers, and professors—we hope that benefits will filter down to the largest number of students.

Recombinant DNA for Beginners

The pivotal achievement of the Curriculum Study has been the development and testing of an integrated series of laboratory exercises that give students hands-on experience in molecular biology. With strong technical help from Dr. Greg Freyer,

Instructors Greg Freyer and David Micklos observe Northport H.S. student Robert Kehn.

now a research associate at Memorial Sloan-Kettering Cancer Center, we have successfully adapted protocols and techniques used by practicing researchers so that they can be safely used in the classroom. These experiments at once excite imagination and give insight into the process of scientific discovery. When published in late 1986, these experiments will be the first lab/text available for this level of instruction.

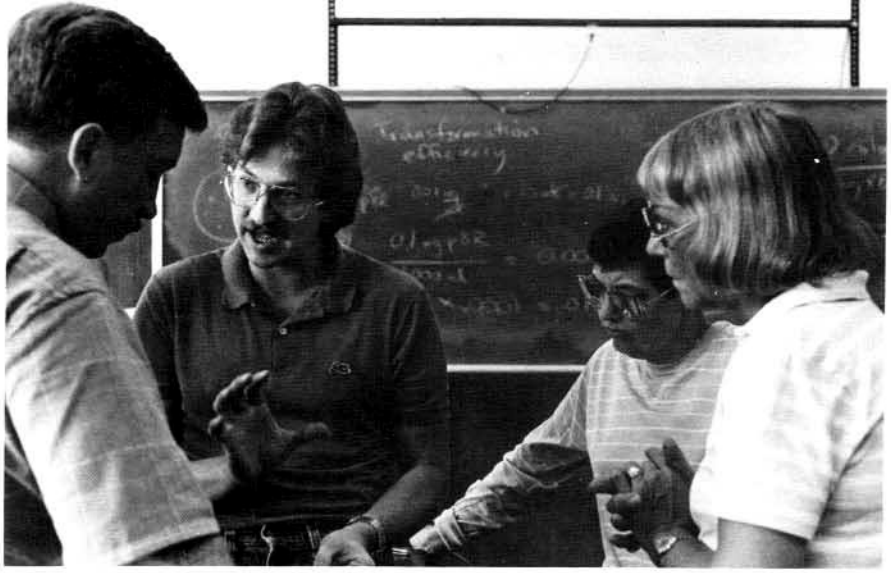
Another important achievement was the development of *Recombinant DNA for Beginners*. Telescoping instruction equivalent to a three-credit college course, this five-day course gives teachers hands-on experience with the elegant tools of biotechnology. Using equipment identical to that found in research laboratories, teachers perform nine experiments that culminate in the production and analysis of recombinant-DNA molecules, including: microbial culture, gel electrophoresis, DNA restriction analysis, DNA ligation, plasmid transformation of *E. coli*, and purification of plasmid DNA.

Morning lectures introduce major concepts and theories behind the experimental techniques. Afternoon seminars presented by practicing researchers illustrate the application of molecular approaches to solve biological problems.

Facilitating Classroom Implementation

In addition to bringing teachers up-to-the-minute with research in molecular biology, this course is designed to help participants transfer what is learned into improved classroom methods. Post-lab discussions alert educators to variables that can influence classroom results and show how to "troubleshoot" when something goes wrong. One session introduces a small-group approach for analyzing the personal, social, and biological implications of recombinant DNA. Another session focuses on practical aspects of starting a laboratory teaching program, including how to build consensus and support, finding funds for equipment, how to schedule labs around time constraints, lab safety, and proper disposal of biologicals.

University of Connecticut Professor Irwin Greenblatt explains maize genetics at Honors Colloquium for students from 19 local school districts.



Greg Freyer explains subtleties of bacterial transformation to local high school teachers at the summer workshop: Steve Sponenberg and Lois Miller, Syosset; and Henrietta Dold, Wheatley.

An Expanding Role

Only one year after its founding by the Laboratory and eight local school districts, the Curriculum Study has grown into a consortium of 19 school districts on Long Island and in Westchester County. The largest program of its kind, the Curriculum Study serves as a national model for retraining teachers and retooling classrooms for laboratory-based learning about molecular biology.

During its first year of operation, the Curriculum Study provided approximately 100 hours of advanced instruction to both students and teachers—equivalent to three college courses. Approximately 40 teachers and 300 students have attended Curriculum Study seminars, workshops, and training sessions. The number of students who, in turn, have benefited from the retraining provided to their teachers can be conservatively estimated at 4,000. This number will compound each year.

In 1986 we are initiating two new projects to expand significantly the scope of the Curriculum Study:

Vector Mobile DNA Laboratory. In molecular biology, the term *vector* describes bacterial plasmids or viruses that are used to ferry new DNA fragments into a host cell. In the same way, the Vector Mobile DNA Laboratory will carry new knowledge and teaching methods to educators around the country. We have purchased and equipped a utility van as a mobile laboratory to transport all necessary equipment for regional workshops held for up to 36 teachers and/or students. During summer 1986, the Vector Laboratory will travel to workshop sites around the country, including: Huntington and Westchester County, New York; Boston, Massachusetts; Concord, New Hampshire, Milwaukee, Wisconsin; Chicago, Illinois; and Davis, California.

DNA Education Center and Museum. Serving as a national clearinghouse for up-to-the minute information on biotechnology and DNA science, the DNA Center will be unique among educational institutions in the United States. A Science Media Resource Unit, located within the Center, will explore innovative methods and technologies for presenting science concepts in an exciting and stimulating fashion. Through teacher-training courses administered in the teaching laboratory at Cold Spring Harbor and several mobile laboratories that travel to regional workshops, the Museum will make its materials and resources available to educators throughout the country.