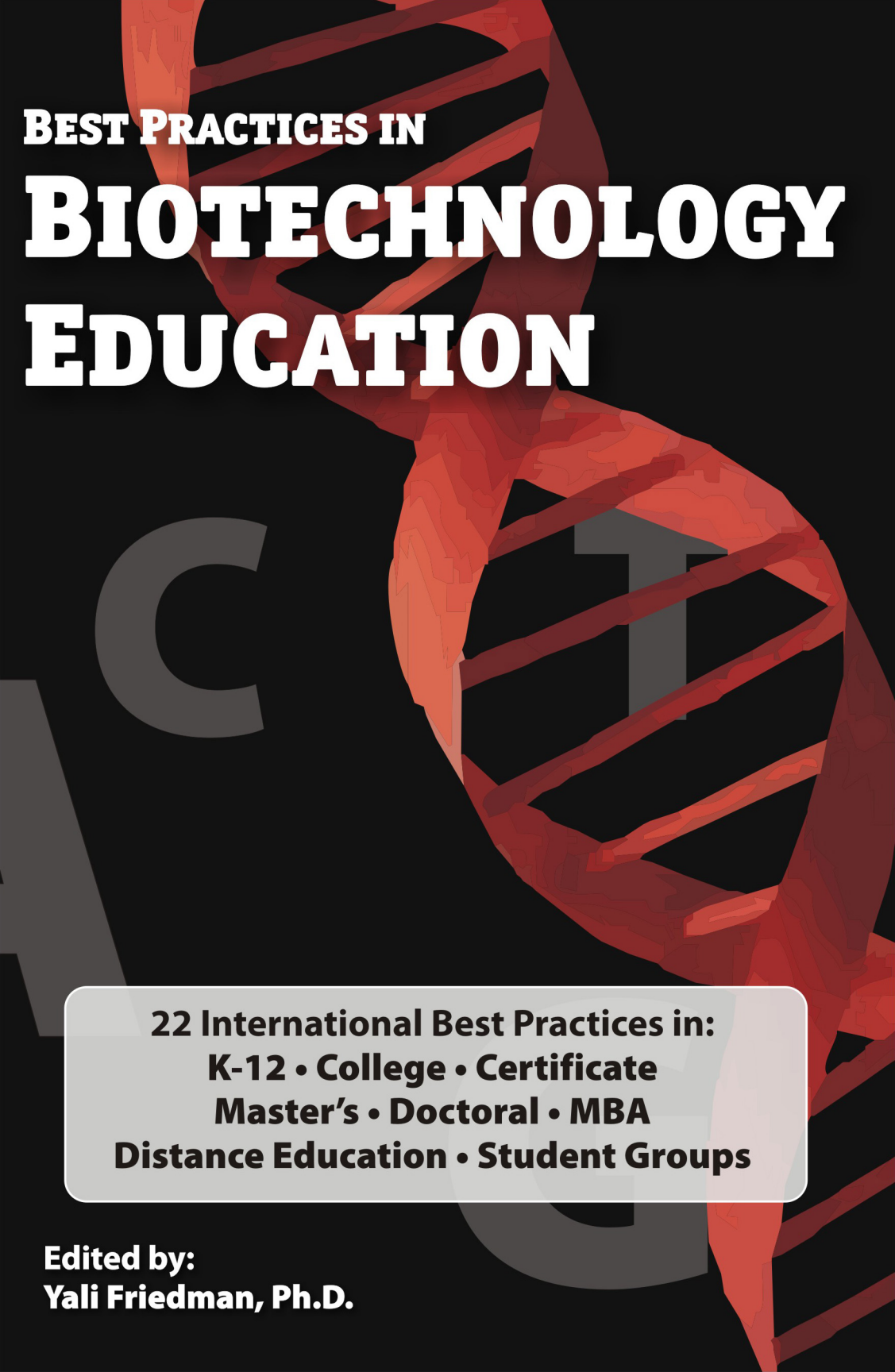
Best Practices in Biotechnology Education



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A Model for Connecting Students and Teachers to the Biotechnology Industry Cluster in San Diego County

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In an effort to prepare a world-class scientific workforce for San Diego, BIOCOM, the industry trade organization and the San Diego Workforce Partnership Inc. have developed a model program that exposes students and teachers to the regions life sciences industry cluster. Ranked third in the world, this industry cluster of over 500 companies and research institutions faces a local workforce shortage as the industry continues to grow and expand. This impending labor shortage led the Department of Labor to fund the San Diego Workforce Partnership Inc. under the Presidents' High Growth Job Training Initiative, as implemented by the US Department of Labor's Employment and Training Administration. The Life Sciences Summer Institute (LSSI) is a collaborative product of this funding to the San Diego Workforce Partnership Inc. and BIOCOM. Initiated in the summer of 2005, the LSSI seeks to foster interest in the life sciences among upper-level high school, community college and university students as well as high school teachers. The ultimate goal of the program is to give San Diego's future workforce early exposure to the life sciences industries.

This model has three specific objectives:

- To provide industry with well-prepared interns
- To provide students hands-on experience within the life sciences industry
- To better equip teachers to prepare our future workforce

This sustainable model addresses both the impending labor shortage as well as the math and science education crisis facing our nation's educational system.

KEY COMPONENTS OF THE PROGRAM

Initial efforts in late 2004 brought industry and education together to develop the program. The key elements were developed initially and several refinements have been made over the past three years based on continuous feedback from key stakeholders, students, teachers, and industry.

STUDENT PROGRAM

- Student Selection Process: A "temp agency" placement model where student applications are pooled and students are interviewed and 'hired' by host institutions
- *Boot Camp: Introduction to the Biotechnology Industry.* One unit college credit class at San Diego Miramar College prior to the start of the industry internship (one week of industry defined hard and soft skills).
- Industry Internship: A 7-10 week industry or research institute experience paid for by host institution
- Student Exhibition: A follow on event "Celebration of Science Education" where student posters are exhibited to the life science community

TEACHER PROGRAM

- Curriculum Training (Standards Based): High school and community college teachers are trained on the Amgen-Bruce Wallace Biotechnology Laboratory Program at the Biogen Idec Community Lab
- Externships: Teachers visit a variety of industry sites for half day 'externships' to view both hard skills and soft skills in practice. Exposed to working professionals *in situ,* these teachers can explore the expectations of educational outcomes in the workplace.
- Curriculum Sharing & Peer Networking: Teachers have the opportunity to share-out "best practices" and network amongst each other.
- Ongoing Support for Curriculum Implementation: Teachers who have no equipment or follow on support receive free supplies, loaner equipment, and staff support to implement the curriculum (Grant funding from Amgen Foundation).

THE PARTNERS

IMPLEMENTATION

- The San Diego Workforce Partnership Inc. has been coordinating job training and employment programs for more than thirty years. Created under a Joint Powers Agreement by the City and County of San Diego, the Workforce Partnership brings qualified employees and area businesses together.
- BIOCOM, the industry and trade association for San Diego's life sciences community. The BIOCOM education and workforce committees serve as steering committees for these programs.

MAJOR SUPPORT: INDUSTRY AND FOUNDATIONS

Biogen Idec has generously hosted the LSSI Teacher Externship Program for the past three years in their state-of-the art Community Lab facility, in addition to hosting student interns and providing teacher externship experiences. One of the unique aspects of the Community Lab is that it takes teachers out of the classroom and brings them into a working environment where science is applied every day.

> *"Biogen Idec, the world's third largest biotechnology company, is extremely interested in increasing the pool of potential scientists that could become our employees, especially from within the communities that have been traditionally underrepresented in science. Our partnership in the Life Science Summer Institute provides Biogen Idec with the opportunity to reach even more students and teachers. Biogen Idec is committed to the continued use of our Community Lab for the duration of the LSSI, providing teachers with access to state-of-the art equipment and biotechnology professionals at all levels of our company."*
> Annie Glidden, Director, Biogen Idec Community Lab

One of San Diego's largest biotechnology companies, Invitrogen, has also partnered with the LSSI programs to advance and promote science education throughout the region. Invitrogen has donated thousands of dollars in Invitrogen products to supplement both the student and teacher laboratory training programs, and has more recently donated $7,500 to support sustainability efforts of the LSSI Teacher Externship Program.

> *"From student internships to teacher externships, we are excited about the LSSI programs and believe they will significantly improve scientific literacy at all age levels. Invitrogen's goal is to inspire students and teachers to continue their pursuit of science, and the LSSI program objectives and outcomes align with our own perfectly. Through hands-on, interactive*

programs and dynamic curriculum, LSSI is a valuable partner in growing California's future workforce."
Lisa Peterson, Community Relations Manager, Invitrogen Corporation

On behalf of the LSSI Teacher Consortium, the Southern California Biotechnology Center (SCBC) applied for and was awarded a three-year grant for the expansion of the Amgen-Bruce Wallace Biotechnology Laboratory Program into San Diego County, through current and future LSSI graduates. The funding obtained allowed for the purchase of equipment and supplies to make transferable "laboratory kits" for rotation throughout county classrooms. An outreach coordinator was hired to oversee the distribution of these kits. The outreach coordinator responsibilities also include working with the teachers throughout the LSSI program, and providing ongoing support to LSSI teachers implementing the Amgen curriculum into their classrooms throughout the school year.

"I feel that we have really made a breakthrough in that we now have a mechanism and process in place to help teachers implement new lab curriculum covered during the LSSI into their classrooms."
Martin Ikkanda, Professor of Biology, Pierce College (LSSI Teacher Curriculum Instructor, Amgen-Bruce Wallace Biotechnology Lab Program)

MAJOR SUPPORT: EDUCATION

- The Southern California Biotechnology Center (SCBC) @ Miramar College, one of six CalABC Centers (California Applied Biotechnology Centers) funded by the California Community College Chancellors Office, works to prepare the local workforce for the regional industry cluster. The SCBC developed the hands-on laboratory curriculum utilized during the student

biotechnology "boot camp" trainings at Miramar College, allowing the use of the laboratory equipment and facilities. The biotechnology "boot camp" is an accredited course offered by the college (*Introduction to the Biotechnology Lab*). Each student who successfully completes the course receives one full unit of college credit. In addition to creating the training curriculum, and providing laboratory space and equipment, the instructor fees are also paid for by the college.

- California State University, San Marcos, provides the option for teachers to obtain credit for their participation in the program. The units earned by the teachers are academic semester units that are reported on official university transcripts with a grade attached.

HISTORY OF THE LSSI

CATALYST FOR CREATION OF THE PROGRAM

A President's High Growth Job Training Initiative Grant obtained by the San Diego Workforce Partnership Inc. from the U.S. Department of Labor, Employment and Training Administration, and with support and leadership from Biogen Idec and the Southern California Biotechnology Center (SCBC) at Miramar College, the Life Sciences Summer Institute (LSSI) kicked off in the summer of 2005. This funding fully supported the program for the first three years. A model of sustainability in the absence of such grant funding is one of the current challenges facing the program.

DEVELOPMENT OF THE PROGRAM: AN EMBEDDED CONNECTION TO BOTH INDUSTRY AND EDUCATION PROVIDES INDUSTRY RELEVANT EXPERIENCE

The San Diego Workforce Partnership Inc., along with its partner BIOCOM established a taskforce committee, comprised of industry professionals (community relations and human re-

sources representatives, hiring managers, and scientists) and educators (San Diego County Office of Education K-12 science coordinators, community college and university science department chairs, internship coordinators, and school administrators) to formulate and design the internship and externship programs for students and teachers. This cross-functional and diverse taskforce conducted a needs assessment of the region prior to breaking off into sub-groups to further work on program design, curriculum development and outreach models for the initiatives identified.

In addition to this Taskforce and working sub-groups, BIOCOM facilitates several committees to ensure the needs of the industry are being served and partnerships are formed. Members from life sciences companies, research institutes, academic institutions, staffing agencies, the San Diego Workforce Partnership, and the State of California Employment Development Department (EDD) meet regularly to discuss workforce needs, the educational pipeline and career ladders. At the board level, presidents and CEOs steer initiatives through the Workforce Capabilities Committee. Under this committee are the human resources subcommittee and education subcommittee that provide feedback and make decisions and recommendations for the further development and continued success of the LSSI programs. This structure allows for maximum input from interested parties, and fosters participation from industry at multiple levels.

INDUSTRY RELEVANT CURRICULUM & TRAINING

STUDENTS: BOOT CAMP TRAINING & INTERNSHIP

This one week intensive lab training with soft skill awareness exposes the students to a working biology laboratory as it relates to the region's life science industry. The laboratory addresses basic skills and techniques common to the industry including measuring activity and quantity of proteins, growth and manipulation of bacteria, genetic engineering, polymerase chain reaction and antibody methods. In addition to hands on skills, the course provides context for how and why these techniques are used in the industry.

Workplace relevant soft skills include communication, teamwork, and workplace expectation exercises. This boot camp has been institutionalized by San Diego Miramar College as a course called *Introduction to the Biotechnology Laboratory*. It is taught in a flexible format of 5 days in class with the sixth day on-site in internship. Students are required to do at least 7 weeks of paid internship. The program has produced uniformly positive testimonials:

Intern Mentor: *According to Dr. Terri Quenzer, principal scientist of Pfizer Global R&D La Jolla Laboratories and mentor of multiple LSSI interns, "LSSI's 'Boot Camp' training gives interns a smooth transition from school to industry environment, the interns come in much better prepared."*

High School Student: *Ironically, Summer Puente had loathed her high school Biology course. "The 'Boot Camp' opened my eyes to 'real biology' and how to work in a lab," Summer states. "And the training on 'soft skills' really prepared me for my internship." After completing the training in the "Boot Camp", Summer interned at the Salk Institute in La Jolla. "I came into the program knowing next to nothing about biology. I struggled initially, but by the end I was grabbing all the materials out of the freezers, checking and re-checking them, and basically running the experiment." Summer now plans a life science career.*

College Student: *After completing his internship program with Invitrogen, Billy Chiu decided that he would like to start his career with Invitrogen. "My experience with Invitrogen made it easy for me to get my job, because I already worked there…LSSI taught me that I wanted to work in this industry, and that I wanted to work for a large biotech company."*

Industry Host: *"To bring innovations, creativity, and enthusiastic young people to the company!" Ms. Theresa Schommer responded immediately, while being asked why Invitrogen, employer of hundreds of engineers and scientists with advanced degrees, runs a student internship program.*

TEACHERS: LABORATORY CURRICULUM TRAINING AND INDUSTRY EXTERNSHIP EXPERIENCES

The Amgen-Bruce Wallace Laboratory Program curriculum is the foundation of the teacher and student experience. Consisting of 8 laboratory exercises which can be conducted in typical high school class periods this program exposes the participants to three Nobel Prize techniques and are built around four central paradigms: 1) recombinant DNA technology, 2) gene expression, 3) protein purification, and 4) the polymerase chain reaction (PCR). During week one of the teacher externship training it is expected that teachers gain only a 'student' perspective of these laboratories; curriculum troubleshooting and ongoing support are necessary for teachers to actually implement the labs in their own classrooms.

The industry externships are a key component of the program. The externship experiences give the teachers a context for the science, and exposure to industry professionals who describe both their science and career paths. The diverse industry cluster in San Diego requires that teachers be exposed to at least one large manufacturing site, a large research and development site, a small start-up environment as well as a research institution. The LSSI has been fortunate to have all of these experiences available to the teachers. The hosts provide staff and careful planning that make this an excellent and lasting experience for the teachers. Teacher deliverables from this experience include background research on the hosts as well as a final presentation providing a regional industry overview.

For high school teacher Malinda Dixon, perhaps the most lasting result of her participation in the LSSI will be the Biotechnology class that she plans to introduce next year—one full year covering biotechnology and its real world uses! Malinda arranged training on the curriculum for all of her colleagues. Her one wish is to have more high school life sciences teachers get involved in the program. "It's absolutely important for high school teachers to participate in the LSSI."

The LSSI Teacher Externship Program is a paid professional

development experience, participants are paid in the form of training stipends. In addition, participants have the option to obtain academic semester units from a California State accredited university.

ONGOING SUPPORT AND IMPLEMENTATION

In 2004 it was recognized by the initial 9 teachers that most professional development programs lack on-going support. In the case of the curriculum provided to teachers in the LSSI, the equipment start up costs are over $40,000 and ongoing supply requirements exceed the entire supply budget of most high school science departments. The teachers partnered with the SCBC and sought funding for 'loaner' equipment and supplies. This support was generously provided by the Amgen Foundation.

However, implementation of the Amgen-Bruce Wallace Laboratory curriculum in the high schools also required an element of labor intensive preparation that most high school teachers lack time for. To address this need, the SCBC employs an Outreach Coordinator to assist teachers with their implementation. In a strategy of learned independence it is anticipated that in three years time, teachers will have developed infrastructure and expertise to leave little need for support other that supplies and occasional loaner equipment.

MEETING THE LOCAL ECONOMIC AND WORKFORCE NEEDS

San Diego, the State of California and the nation have been experiencing a significant and growing crisis in the area of math and science education. As San Diego continues to grow as a world-class hub for biotechnology, science and innovation, the young people growing up in San Diego are not being inspired and prepared to fill the high-skill, high-wage jobs being created within the local economy. The LSSI was created to address this issue head on and at multiple academic levels.

The U.S. Department of Labor's goals were at the heart of the development of the LSSI, as each program was established based

on collaborative needs assessments of our region's 21st century workforce. The LSSI focuses on the training and development of upper-level high school, community college and university students as well as high school and community college teachers to create a pipeline of qualified and informed workers for the future. The LSSI programs successfully bridged the gap between industry and academics by providing students with the tools, knowledge and real-world experiences needed to pursue careers and make informed academic decisions. The programs also provided classroom teachers with a more intimate knowledge of the life sciences industry and prepared them to create curriculum and classroom activities that are more relevant, exciting and beneficial to the students they teach.

MEASURES OF SUCCESS

The program model was built to sustain the local workforce. However, there is also an overarching goal to improve scientific literacy by exposing students to the modern biological advances demonstrated by the laboratory activities in the Amgen-Bruce Wallace Biotechnology Lab Curriculum; engage them in the process of scientific discovery, increase scientific literacy, and allow them to develop critical thinking skills.

Effectiveness in meeting this goal is measured in 'hard terms' by how many students and teachers are benefiting from the program. To date, this program has been a great success:

	Summer 2005	Summer 2006	Summer 2007
Student Applicants	38	127	198
Student Internships	13	44	61
Teacher Participants	9	18	24
Companies hosting internships or externships	22	30	25
Approximate Direct Cost	$226,089	$311,917	$260,061
Leverage Match*	$266,836	$396,755	$452,793

* *Includes Southern California Biotechnology Center Outreach Coordinator and Funding from the Amgen Foundation to support the Amgen-Bruce Wallace Curriculum implementation*

In the first half of 2007, 8 schools implemented the curriculum learned during the LSSI program having an impact on 1,228 students. Three teachers received independent funding for equipment, and over 3,000 students benefited from exposure to enhanced hands-on laboratory curriculum instruction. Several teachers implemented the labs on their own and the effect of the industry externship experience has allowed teachers be more informed when providing career advice to their students. It is estimated that each teacher reaches an average of 189 students per year. As this program expands the number of students reached will grow exponentially. Approximately 6,804 students benefited from the program overall to date (September 2005–June 2007).

Following summer 2007, the LSSI program placed a total of 118 students into hands-on internship experiences at local industry companies and research institutes. Twenty percent of the interns placed in these life science internships continued to work either part-time or full-time for the companies in which they interned. Lastly, evaluation results from both the student and teacher LSSI programs indicate that 100 percent of the participants would recommend the program to their peers.

SUMMARY AND FUTURE CHALLENGES

It is evident that it takes time to develop and implement a program of sufficient scope and depth to attract participants. The relatively slow implementation allowed the stakeholders to develop and refine the program such that a sustainable model can be articulated to other regions. Program metrics show that the program is gaining recognition and acceptance; students who participated in the 2007 program were directly referred by past teacher participants. In addition, past success has prompted an increased interest in the program and overall acceptance.

The LSSI is a unique, replicable program that ensures a local workforce for a major industry cluster in Southern California. The student program sparks interest in life science careers. The teacher training, and the support it provides, allow the education

system to better provide industry awareness and improved basic science literacy. Although some key elements of the program have developed 'institutional' support, a major future challenge is the ongoing funding needed to provide training stipends for participants as well as sustain staff members who coordinate and support program activities.

As acceptance of the program continues to grow, we will be careful to not stray from our original goal of better connecting local students and teachers to the life sciences community. We have worked to develop true partnerships where each organization is making an investment in the program and in turn can benefit from its success. We will continue to approach growth and sustainability in a strategic fashion that does not water down the program quality that has become so important to our business and education partners. With each step we take, we will aim to inform, educate and inspire the students we reach, while continuously supporting the teachers who play such a critical role in their development.

We have made a long-term, collaborative investment in this program: an investment that will no doubt pay off for our youth, our education system and the 21st Century workforce that will continue to make San Diego a hub of scientific discovery and region of unprecedented economic growth and opportunity.

ACKNOWLEDGEMENTS

Key Partners

San Diego Workforce Partnership Inc., BIOCOM, Biogen Idec, Invitrogen Corporation, Southern California Biotechnology Center (SCBC) at Miramar College, and The Amgen Foundation

Participating Companies (Hosts for Students Internship and Teacher Externships)

Accumetrics, Alexion Antibody Technologies, Anadys Pharmaceuticals, Arena Pharmaceuticals, Assure Controls Inc., Biogen Idec, BioServ Corporation, Burnham Institute for Medical Research, Conatus Pharmaceuticals, Conservation and Research for Endangered Species (CRES), The Dow Chemical Company, eStudySite, Genentech, Genomatica, Genoptix,

Gen-Probe, Invitrogen Corporation, Isis Pharmaceuticals, Karl Strauss Brewing Company, Nanogen, Pfizer, Salk Institute for Biological Studies, San Diego State University Labs, Santarus Inc., SCBC@Miramar College, SGX Pharmaceuticals, Sharp Chula Vista Medical Center, Skin Medica, Sunrise Science Products, The Scripps Research Institute.

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