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English, Algebra, Phys Ed ... and Biotech

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George Cachianes, left, formerly of Genentech, teaches biotechnology at Lincoln High School in San Francisco.

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MORE than a decade ago, after George Cachianes, a former researcher at Genentech, decided to become a teacher, he started a biotechnology course at Lincoln High School in San Francisco. He saw the class as way of marrying basic biotechnology principles with modern lab practices — and insights into how business harvests biotech innovations for profit.

If you're interested in seeing the future of biotechnology education, you might want to visit one of George Cachianes's classrooms. "Students are motivated by understanding the relationships between research, creativity and making money," he says.

Lincoln has five biotech classes, each with about 30 students. Four other public high schools in San Francisco offer the course, drawing on Mr. Cachianes's syllabus. Mr. Cachianes, who still teaches at Lincoln, divides

his classes into teams of five students; each team “adopts” an actual biotech company.

The students write annual reports, correspond with company officials and learn about products in the pipeline. Students also learn the latest lab techniques. They cut DNA. And recombine it. They transfer jellyfish genes into bacteria. They purify proteins. They even sequence their own cheek-cell DNA.

Cool, eh? And very, very important.

We know the refrain by now: the United States, birthplace of most of the great commercial advances of the last 60 years, must increasingly rely on overseas talent, otherwise known as imported brains, to maintain an edge.

Talented immigrants are crucial to American vitality, and employers are smart to woo them. But research universities aren’t content to rely only on the overseas pipeline, and are working to make science and engineering studies more appealing to American students.

Sometimes overlooked in this mix is how high schools can help cultivate a fresh crop of scientists, engineers and lab technicians. Secondary science and mathematics education is on the rise, with growing numbers of students in more challenging classes. Enrollment in advanced biology and physics courses doubled from 1997 to 2004, nearly doubled for advanced math and rose 50 percent for advanced chemistry, according to the National Science Foundation.

Advanced classes are just one response to the drive for more American innovators. Another is to give high school students more hands-on experience with innovation, which, in the real world, is how researchers pursue their passions. Exposing students to experiments, data crunching and lab floors, of course, helps make academic abstractions more concrete.

“We moved away from hands-on learning when we thought computers could simulate everything,” says G. Wayne Clough, president of the Georgia Institute of Technology in Atlanta and a member of the National Science

Foundation's board. "Now we're moving back to hands-on, and high school is a great place to begin."

Some public high schools are giving students lab experiences that approach, or even exceed, those found in university settings. And some teachers see an economic payoff in all of this. Biotechnology, for example, remains a promising field, and companies in the industry have less math-intensive demands than electronics and computing employers. So biotech is a popular field with students and is emerging as an educational proving ground.

"Our whole goal is to transform the work force," says Xan Simonsen, who coordinates the biotech program for high schools in Mesa, Ariz. The schools follow a curriculum very similar to San Francisco's, including an emphasis on learning about the biotech business.

To be sure, biotech lab work is expensive. Mr. Cachianes's classroom in San Francisco has about $500,000 of equipment, obtained mainly through grants and donations from local companies. (The spending total was similar for the Mesa district's biotech labs.)

"What Mr. Cachianes is doing is very high end, but he shows what's possible," says Paul A. Hanle, president of the Biotechnology Institute, a nonprofit group in Arlington, Va., that provides training for secondary school teachers.

While the institute promotes a low-cost alternative for teachers that it labels "biotech on a shoestring," Mr. Hanle says "high-end programs in high schools are growing significantly."

San Francisco's high schools continue to have one of the most sophisticated biotech programs in the country, perhaps because of the city's proximity to thriving biotech companies.

THREE years ago, Mr. Cachianes began offering a second, more advanced biotech course in response to requests from seniors who had done well in his other class. Last spring, Wendell Lim, a molecular biology professor at

the University of California, San Francisco, learned about the course and chose five graduating seniors to work in his lab over the summer.

Active in the emerging field of synthetic biology, which marries engineering, computing and biotech, Dr. Lim wanted the team of students to enter a Massachusetts Institute of Technology contest.

Dr. Lim asked Mr. Cachianes's graduating seniors to carry out two experiments: one to create a protein "scaffold" to control the flow of information in a cell, and the other to create the cellular version of an electronic bar code. "These kids took a while to gain confidence, but by the end of the summer, their experimental work was as good or better than a lot of our graduate students'," Dr. Lim said.

This month, the Lincoln-U.C.S.F. team, all of whose members now attend public universities and colleges in California, flew to M.I.T. to present its findings. Competing against 57 teams from universities representing 20 countries, it snared one of six finalist spots. A team from China won.

The lesson here is that seeds of innovation are sown in high school — and that setting higher expectations can encourage better performance. "Our kids can shatter limits," Mr. Cachianes says, "if we adults take a risk and give them the chance to try."

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