

Make Biology the Recruiting Ground for Biotechnology Courses

Biotechnology courses are popping up all over the country, with several hundred community colleges and high schools developing programs that prepare students for a rewarding career in biotech. This is not surprising since biotechnology is a high-interest area for both students and teachers. Educators find that teaching the processes of biotechnology empowers them and improves their own science skills. Biotechnology courses arm students with the experiences and knowledge needed to make good decisions about their future.

Biotechnology courses allow science educators to teach in a way that students develop a love for the process as well as the concepts of the biochemical sciences. Students learn research skills and get an idea of what it feels like to work in a laboratory environment. Biotechnology courses help develop the scientists, research associates, lab technicians, and science-literate citizens needed in our rapidly changing science-based society. Unless educators give their students experiences in the processes of biotechnology, how are students supposed to know they are interested in biotech careers and how can they be expected to make academic decisions that lead them to those careers (see Figure 1)?



Insert Figure 1 Senior Manufacturing Technician Kevin Johnson, a Senior Manufacturing Technician at Affymetrix, Inc, primarily operates and maintains the high-throughput filling systems that dispense the reagents that accompany the instruments used to create and read microarrays. Microarrays are used to study gene expression and genetic diversity. Gene targets for pharmaceutical research are often found using microarrays. Kevin uses, calibrates, and validates an assortment of common lab equipment and trains new lab employees. Learn more about Affymetrix's GeneChip® arrays at www.affymetrix.com. Photo by author.

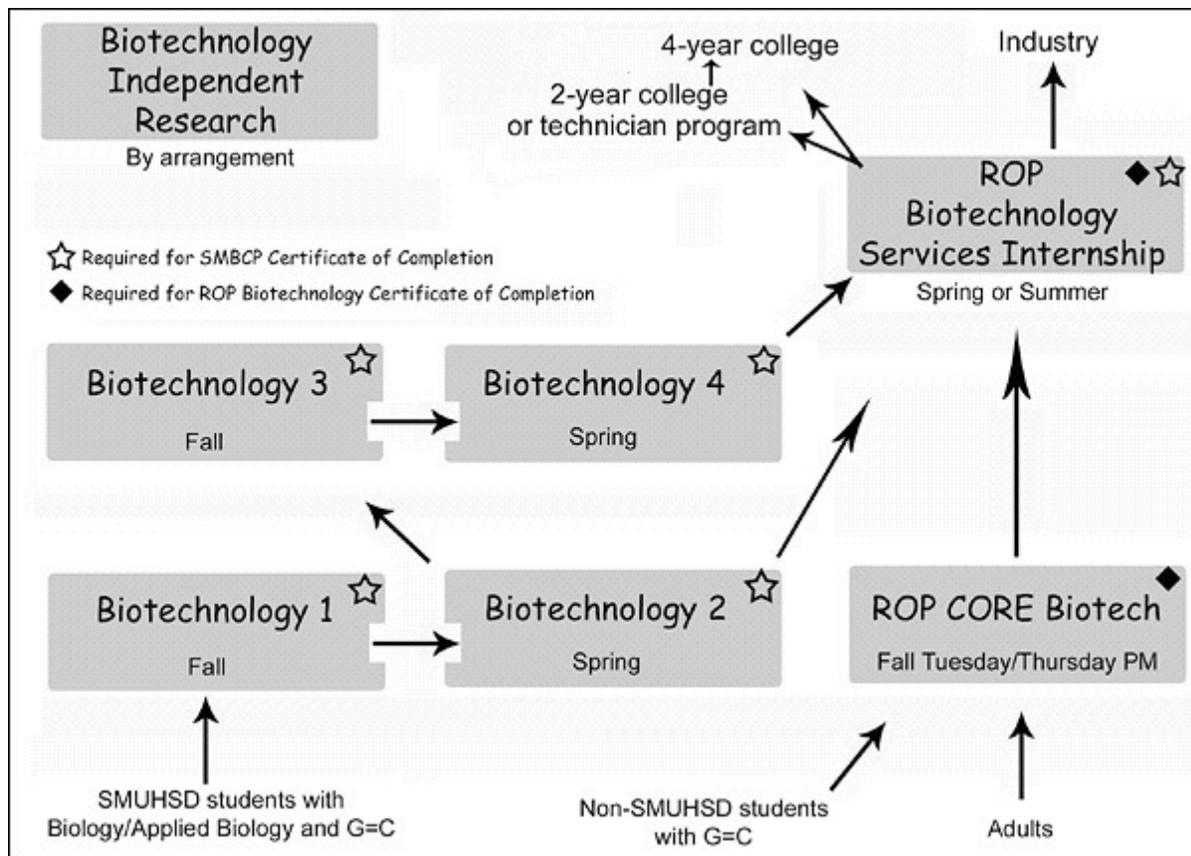
When asked what biotechnology is, a typical response from an American teenager is, “CSI.” Although, forensics is a field that utilizes the tools of biotechnology, it is like cottage cheese in the dairy section of biotech, just one important application of biotechnologies. Without an exposure to many of the introductory techniques and applications of laboratory biotech and the production of pharmaceutical, agricultural, industrial, and diagnostic products through biotechnologies, students can not be expected to have the information or interest to make decisions that lead them to academic and career choices in biotechnology. It is important to consider student recruitment strategies when planning a biotechnology program.

An Example of a Biotech Unit for Biology

The teaching staff and advisory committee of the San Mateo Biotechnology Career Pathway (SMBCP) program have given considerable time and attention to recruiting students from the middle 50% of the student body. The SMBCP consists of courses that train adults and teenagers to enter the biotechnology workplace as laboratory or bio-processing technicians, with courses in

the San Mateo Biotechnology Training Center and in laboratory internships at one of 25 industry and academic partners (see Figure 2). Depending on the student and the certificate they prefer, students may stay in the program from one to four years. The SMBCP program runs five 1st year courses of Biotechnology 1-2 for teenagers each year and recruits 175 new sophomores and juniors into these courses. These students represent all academic and socioeconomic levels. To successfully meet these enrollment goals, the San Mateo Union High School District (SMUHSD) science teachers implement several methods to educate potential students about the science and industry of biotechnology and stimulate their interest in the opportunities in the field.

Insert Figure 2 The San Mateo Biotechnology Career Pathway



An introduction to biotechnology for SMUHSD students begins in the freshman biological science course. All students in the district have a science course during 9th grade. This course may be Biology 1-2, Applied Biology 1-2, Life Science 1-2, or Integrated Science 1-2. Each of these courses includes a 4-5 week biotechnology unit called “The Gene Connection®.” How “The Gene Connection®” (G-C) unit is implemented at a site depends on the school. Science teachers at a school site may choose to run their own version of “G-C” type activities or may participate in G-C training and then have access to the equipment, materials, or curriculum available from the San Mateo County Gene Connection® program.

At San Mateo High School, students in all of the Biology/Applied Bio classes (the prerequisite course for Biotech 1-2), complete approximately 4-5 weeks of a biotech primer that consists of 6 lab activities, a few videos, and some bioethics activities. The activities (see Table 1) are provided as kitted experiments from the County Office of Education (but all are available as

simple lab activities on the Internet or as kits from several vendors, among them Ward's, Edvotek, Carolina Biological, and BioRad):

Insert Table 1 Suggested Biotechnology Unit (Biotech Primer) for Biology Course

Biotech Primer Activity	Objective	Vendor/Source	Comments, Notes, Cautions
Strawberry DNA Isolation and Spooling	Students isolate DNA from cells of a plant.	Lots of these are found on the WWW. Try www.exploratorium.com or find the web article, "Extract DNA from Anything."	Wheat germ DNA isolation works well
Introduction to Micropipeting	Students learn how to measure very small volumes using a variety of micropipets.	Lab 3b from <i>Biotechnology Science for the New Millennium</i> or a similar one.	It is pretty easy to develop your own micropipeting tutorial using food coloring dyes
Introduction to the Chemistry and Physics of Gel Electrophoresis	Students run gel boxes empty, with water, with salt, with buffer, + phenol red) studying charge, current, and voltage.	Find a version on the WWW	Caution: Learn the electrical hazards associated with gel box use.
Preparing, Pouring and Running an Agarose Gel	Using colored dyes, students learn about molecular behavior in a gel placed in an electric field.	Several kits are available from science educational supply vendors.	Be sure to include positively and negatively charged molecules.
pGLO transformation of <i>E. coli</i>	Students conduct a genetic engineering procedure to create a GMO.	Several kits are available from science educational supply vendors.	Include Nova® or Frontline® videos on GMOs prior to the pGLO lab and bioethical dilemmas afterwards.
DNA fingerprinting	Students conduct a DNA fingerprint simulation using restriction enzyme digestion fragment length polymorphisms (RFLPs).	Several kits are available from science educational supply vendors.	Include Nova® or Frontline® videos on DNA studies/forensics prior to DNA fingerprinting and bioethical dilemmas afterwards.

Recruiting Middle 50% Students

The biotechnology unit is one of extreme interest for biology students and upon its completion the San Mateo Science staff begins recruiting students into the multiple year, elective biotechnology career pathway. Recruitment starts with teachers bringing all "biology" and "chemistry" classes to the biotechnology-training lab for a "field trip." Three to four classes at a

time come for 10-minute presentations that introduce students to the biotech career pathway. The field trip culminates with a 5-minute tour of the lab facility. During the tour, regularly scheduled biotech classes are working in the lab and future students get to see current students, their peers, in action. During the field trip, all students are reminded of benefits of participating in the biotech program and are encouraged to sign up for biotech classes, with their counselors, during the regular course sign-ups (see Figure 3).



Insert Figure 3 – Student Intern
Students who complete one or more years of the SMBCP may apply for a laboratory internship at one of the program’s 25 partner biotechnology companies. Over 800 students have completed an unpaid laboratory internship. Approximately 40% of SMBCP students have continued into to some kind of paid employment. Here, a student intern checks samples on a UV spectrophotometer.

Many middle 50% students are “science-shy”, academically unfocused, or inexperienced and may consider signing up for biotech but do not follow through. For those students, we make an extra effort to recruit them. We ask the biology teachers to identify a few students each that are either Biology 1-2 students working below expectation or students that show promise in Applied Biology/Life Science. These students are invited to a lunchtime “root beer party” in the biotech lab. These students are sent engraved invitations and their parents receive letters asking them to encourage their student to attend. For those students that come and listen to a biotech signup sales pitch, their reward is a root beer float (of course we share with them how ice cream and root beer are products that have been impacted by the biotech industry). At the ‘party’ we have forms that students can fill out to sign up for the next term of biotech. Our goal is to get at least 50 of the “targeted” students to enroll in biotech.

Biotechnology in Biology for Everybody

Biotechnology is growing faster than any other industry and a rapidly increasing number of employees are needed in all sectors of the science and business of biotech. The shortage of appropriately prepared candidates for positions in biotech research and development as well as manufacturing is becoming a serious concern for many bioscience companies. It is such a concern that companies are building strategic alliances with their local educational institutions, including both colleges and high schools, to increase the number of qualified employees. To create the science workforce of the 21st century, we need students of all ages to develop an interest in pursuing a career in biotechnology. Providing biology students with positive lab experiences in biotechnology will increase the number of students entering specialized biotechnology programs and careers in biotech.

Ellyn Daugherty

A 30 –year veteran biology teacher, Ellyn Daugherty started teaching biotechnology in 1988. She was the Founder, Author, Lead Teacher, and Program Administrator for the San Mateo Biotechnology Career Pathway (www.SMBiotech.com). Her model curriculum, *Biotechnology: Science for the New Millennium*, EMC Paradigm Publishing, attracts adults and teenagers into an intensive, multiple-year programs in biotechnology that leads students to higher education and the workplace.

Ellyn has received several awards for her innovative teaching and curriculum development, including, The National Biotechnology Teacher-Leader Award, Biotechnology Institute and Genzyme, Inc. in 2004.

Ellyn believes strongly in teacher professional development and conducts several workshops a year, in her lab, and at national conferences. Her website (www.BiotechEd.com) contains a collection of teacher support materials and information about upcoming workshops.