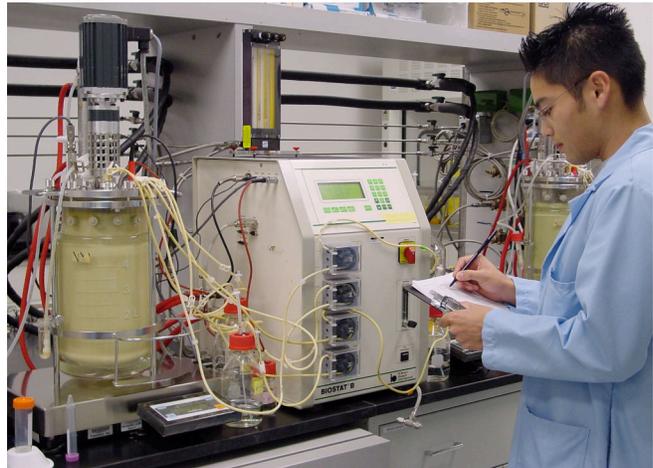


## The Importance of Teaching Biotechnology

You've heard of The Stone Age, The Dark Age, The Industrial Age, The Computer Age, well now we are in "The Age of Biotechnology." Advances in the science and industry of biotechnology are creating exciting and meaningful career opportunities for your students that will last well into the next century.

Biotechnology has become one of the fastest growing industries in the nation. Employment in the biotechnology field increased nationwide by almost 50 percent between 1997 and 2002 (*Careers in Biotechnology, 2nd Edition*) and has continue to grow in spite of global financial challenges. As companies moved from research and development to the manufacturing of pharmaceuticals, industrial, and agricultural products, there was an increase in both biotech science and biotech business job placement (See Figure 1).



**Figure 1 - A manufacturing technician in a recombinant protein pilot manufacturing plant. On the left, the five-liter fermentation flask contains a cell culture producing a protein product of interest.**

In June 2010, SciDATA reported that there were 24,101 biotechnology companies in 38 countries (<http://biotech.emcp.net/SciDATA>). Many companies have research and development, manufacturing, or administrative facilities in several different countries. This gives a biotechnology employee many options for where to work and live, whom to work for, and in what type of role.

Scientific American Worldview 2009 cited the United States, Singapore, Denmark, Israel, and Sweden as the top five countries for biotechnology innovation. These countries lead in biotechnology innovation because they provide excellent protection for intellectual property, they spend a considerable amount on research and development of products, they have excellent support for education and financing, and they compensate their biotechnology employees well. In these countries, robust biotechnology innovation comes with robust business development and outstanding employment opportunities. A quick search on the Internet can provide a lot of information about biotechnology opportunities in these or other countries.

Virtually every state in the United States has some kind of biotechnology industry and employment. Several cities/regions in the U.S. have a significantly large biotechnology-based economy. These include:

New York City, NY  
San Francisco, CA  
San Jose, CA

Los Angeles, CA  
Houston, TX  
San Diego, CA

Dallas, TX  
Minneapolis, MN  
Miami, FL  
Chicago, IL  
Boston, MA  
Philadelphia, PA

Seattle, WA  
Durham, NC  
Salt Lake City, UT  
Washington, DC  
Indianapolis, IN  
Tampa, FL

## A Growing Industry Need for Biotechnology Employees

The biotechnology industry includes a diverse assortment of applications, including any use of living things or their parts to improve the human condition, understand scientific phenomenon or create a product. Many biotechnology products are proteins such as those for medicinal therapeutics or diagnostics. Some of these are harvested from nature and some are made by genetic engineering (recombinant proteins). Most agricultural and horticulture products are the result of biotechnology. Some industrial products are made through biotechnology such as stain-fighting enzymes in detergents and molecules that make tissue softer. Other biotechnology products include the instruments and reagents that are used that are used in scientific research, manufacturing and diagnostics.

As the industry grows, the opportunities for employees are incredible. A variety of workers with a wide-range of education, training, and experience are required (See Figure 2). Common to all biotech employees though must be a basic understanding of the science and economics of the industry. Of course, as in any industry, the more education and experience a potential employee has, the greater are their chances for employment and advancement. The majority of laboratory positions in research and development (R&D) require a four-year college degree, for example, a Bachelor's of Science Degree in Biochemistry (BS-Biochemistry), Molecular Biology, Genetics, or Biology.



**Figure 2 - Motivated individuals can qualify for important biotechnology positions with as little as two years of training and experience.**

As the industry moves beyond R & D though, into the manufacturing of product, technicians with more hands-on training and experience are desired. In fact, currently there is a shortage of lab technicians. The Bureau of Labor Statistics (BLS) forecasts an increase in the need for biology technicians due to “the growing number of agricultural and medicinal products developed from using biotechnology techniques,” with fastest employment growth occurring in the drug manufacturing industry and research and testing firms (The Bureau of Labor Statistics, 2014). Many technical and community colleges have developed two-year training programs, including internships, to address this need.

### **A Critical Need for Biotechnicians**

The shortage of trained biotechnology technicians will be a limiting factor to the growth of the biotechnology industry in other centers of biotechnology throughout the country. After making an investment of hundreds of millions of dollars, biotechnology companies must still hire trained individuals to operate and manage these tightly regulated facilities. Currently, and in the foreseeable future, there is an absolute shortfall of the number of skilled employees needed for both research/development and manufacturing. In fact, companies such as Genentech, Genencor, Genzyme, Gilead Sciences, and Amgen are not only hiring but making deals with educational facilities and their students to get them to focus their education and training for entry into manufacturing.

According to the Batelle/BIO State Bioscience Initiatives, ([http://biotech.emcp.net/BIO\\_main](http://biotech.emcp.net/BIO_main)), 2014 BIO report, "Bioscience Economic Development in the States," U.S. bioscience companies employed 1.62 million employees. The biotechnology jobs that are being created are relatively specialized and thus are relatively, high paying. In 2014, the average annual wage for a bioscience employee was \$88,202, versus the national average of \$49,130 for other employees in the private sector. Depending on the job duties and the type and location of a company, a typical biotechnician might start with a salary of \$43,000 per year and be given excellent benefits as well.

### **Biotechnology Training Programs are Needed Across the United States**

Virtually every state has some kind of biotechnology industry. At the Biotechnology Industry Organization website (<http://www.bio.org/members/>) biotechnology companies and facilities are listed. Most states have a biotechnology industry support organization that is anxious to work with technical and community colleges to prepare the workforce that is needed to attract new biotechnology business to their area (Visit <http://www2.bio.org/members/biostateaffiliates.asp>).

### **Biotechnology Program, Curriculum, and Facilities**

Since biotechnology employees may end up working in a variety of settings, technical preparation programs should begin with a comprehensive course that surveys the basic skills and concepts used in any entry-level position. These include:

- record-keeping
- safety
- scientific methodology
- laboratory instruments and measurement
- making, diluting and storing solutions
- sterile technique
- cell culture
- DNA and protein structure, function, isolation, assay and analysis

Additional courses or units specializing in the concepts and skills needed for local companies should follow. For example, plant cloning and plant tissue culture where plant biotechnology is found and fermentation, protein purification, and formulation where protein pharmaceuticals companies are found.

A training program designed to certify biotechnicians for manufacturing positions would include computer and laboratory facilities. For introductory courses, basic lab equipment and facilities are designed to allow students to work in small groups or individually. There is a significant investment in equipment and reagents the selection of which is dependent on the program/course objectives and how each is designed. For higher-level courses, training and education centers working with local biotechnology industry and industry associations, choose specific course work, training activities, laboratory equipment and supplies to meet the needs of industry partners. Workplace experiences at industry sites (internships) are critical for adequate preparation for any biotechnician program.

The *Biotechnology: Science for the New Millennium* curriculum is designed to give biotechnology educators a platform to build a program that meets the needs of the industry, community, and student population. Learn more about the *Biotechnology: Science for the New Millennium* curriculum on the BS4NM curriculum-specific link at [www.BiotechEd.com](http://www.BiotechEd.com).