Employment and career prospects for bioengineers

Fueled by a stong demand for a talented workforce and increased government and private funding, academic programs in bioengineering are developing rapidly.

David Gough

This is an exciting time for bioengineering. Advances in the understanding of basic biological and cellular mechanisms are accelerating, and are being translated into practical applications that directly affect the public well-being—and that in some cases may lead to fundamental changes in our way of life. At the same time, academic programs in bioengineering are developing rapidly to supply engineering talents, and the bioengineering industry is starting to show its potential through the introduction of health-care products that have high value to the public. Even governmental funding agencies are awakening to the increasing prominence of bioengineering. These concerted developments bode well for the employment and career prospects of bioengineers.

The word "bioengineering" once conjured up images of super-humanoids with integrated replacement limbs or organs that had capabilities far beyond those of the natural tissues. These visions were entertaining but nonsensical. The public now has a more realistic understanding of what bioengineering can do when thoughtfully applied to biomedical problems. This awareness has been brought about by daily newspaper articles describing technological advances in biology and medicine, nightly television documentaries on the use of medical technology to combat illness, and the appearance of new technologies in general medical care procedures. This exposure not only has helped to rehabilitate the image of bioengineering, but also has made people more aware of the need for continued research and the value of technology transfer for the timely application of research results.

What kind of problems do bioengineers work on? The range is very broad, from molecules and genes to organs and whole-body systems. A brief, and certainly not inclusive, list of topics includes drug delivery systems, cardiac physiology and modeling, technologies for imaging the body and its components, biomechanics at the molecular, cell, organ, and whole-body levels, gene systems and their organization, devices for replacing neurological function, tissue engineering, biomaterials for use in the body, organ-replacement systems, molecular modeling, artificial blood, orthopedic devices, biosensors for detecting and monitoring metabolites and identifying specific genetic materials, cardiovascular mechanics and cardiac-assist devices, biochemical processing systems, bioinstrumentation and physiologic monitoring, bioinformatics and the structure of biological information, mathematical modeling and simulation of complex biological systems, application of new approaches to fabrication of devices that incorporate biological components, methods for identification and targeting of cancerous tissues, and sports medicine and rehabilitation. These areas share a common theme: the application and integration of new and classical engineering tools to address biomedical problems.

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Bioengineering is a broad field because most people involved in biological endeavors function as engineers from time to time, regardless of their formal educational training, as opportunities to pursue practical applications appear. Scientists observe nature with the goal of developing a deeper understanding of biological laws by testing hypotheses. A scientist may function as an engineer, with the goal of using the established laws of nature as design rules to synthesize, build, invent, and create. Science and engineering are complementary, but quite different, activities. Few people function exclusively in one realm or the other. In this sense, specialists from such disciplines as chemistry, biology, pharmacology, and medicine often function as bioengineers, even though they may not employ or be familiar with the classical engineering tools. Indeed, bioengineers have little intention of being the sole practitioners of their art—teams of individuals from many disciplines with broad perspectives and talents are needed to tackle the most challenging problems.

National developments in bioengineering

In academia, bioengineering is experiencing unprecedented growth and development nationwide. Student enrollments have surged, probably as a result of the increased public awareness of field. Many universities want to take part in developing practical applications of the "new biology" and are hurrying to develop new programs. A new department of bioengineering has been inaugurated at a major university nearly every month for the last several years, and others are soon to emerge. There are approximately equal numbers of bioengineering and biomedical engineering programs, and they are similar in most regards—program titles are often chosen for historical reasons. The exceptions are certain bioengineering programs that emphasize applications in agriculture and the environment. Universities that have long had graduate bioengineering programs are now expanding them to include undergraduates. This remarkable development has been accelerated by timely resource awards to many institutions by the Whitaker Foundation[1]. It is estimated that over 150 open bioengineering faculty positions are currently advertised or in the near-term pipeline, providing excellent academic employment opportunities for appropriately trained applicants.

The bioengineering industry is also growing. Companies are by and large concentrated in certain areas such as Boston, San Diego, Los Angeles, and the San Francisco Bay area, but the importance of the bioengineering industry to the local and state economy is beginning to be appreciated in other regions, and the present and future importance of bioengineering products for the public. The field is

David Gough is a professor and chair of the department of bioengineering, University of California San Diego, La Jolla, CA 92093-0412 (dgough@bioeng.ucsd.edu).

dominated by young companies, but a number of maturing companies have products in the pipeline or on the market. Investors are gaining a better appreciation for the unique features of the biotechnology sector, and sustained growth is expected. Recruiters from industry claim that the one characteristic that distinguishes bioengineers from other engineering professionals is their keen interest in the end product.

There have been important recent developments in bioengineering at the national level. In the last days of the Clinton administration, a bill was signed into law establishing the National Institute of Biomedical Imaging and Bioengineering, the newest member of the National Institutes of Health (NIH; Bethesda, MD). This recognized the crosscutting role of bioengineering in many projects of the other institutes and will help to further support the NIH mission.

Bioengineering at UCSD

Academic programs in bioengineering have been in place at the University of California, San Diego since 1966, not long after the campus was opened. The highly ranked bioengineering department is part of the Jacobs School of Engineering. The campus was designed to encourage interdisciplinary interaction with its system of undergraduate residential colleges and with the nearby UCSD Medical School, Scripps Institute of Oceanography, San Diego Supercomputer Center, and neighboring research institutions in the La Jolla area. At the undergraduate level, there are four curricular tracks including a mechanical engineering–oriented track, a pre-medical track, a chemical engineering–oriented biotechnology track, and a newly established bioinformatics track. The standard master's and PhD offerings at the graduate level have recently been augmented by a Master's of Engineering degree that provides an option for a design project carried out in collaboration with industry. The department also offers a new interdisciplinary PhD degree in bioinformatics, taught in conjunction with the departments of biology, chemistry, computer science, and mathematics. The department's long-standing Industrial Internship Program provides educational enrichment by placing student interns in local bioengineering companies. This program draws on the substantial number of bioengineering companies in the southern California region and matches about 70 students each year.

The UCSD bioengineering department is ready to occupy a new building, the Powell-Focht Bioengineering Hall, that includes new resources for research and teaching. The building will also house the Whitaker Institute of Biomedical Engineering, a region-wide organization to promote bioengineering interaction among collaborators in the scientific neighborhood, including the Salk Institute, the Scripps Research Institute, and the Burnham Institute. The new building will also be the home of the von Liebig Center for Entrepreneurism and Technology Advancement, which has a mission of advancing the art of technology transfer to industry and, ultimately, the public. The center offers courses on entrepreneurism for students and faculty, provides resources and space for development of practical concepts, and facilitates contact with experts in technology advancement. Powell-Focht Bioengineering Hall will provide a regional center for a variety of bioengineering activities.

Industrial opportunities

A vibrant biotechnology industry surrounds UCSD. One of the most productive and concentrated life sciences clusters in the world, the region is home to a number of companies that employ bioengineers, including Abbott Laboratories, Advanced Tissue Sciences, Alliance Pharmaceutical, Aurora Biosciences, Baxter Healthcare, CardioDynamics, Celgene, Chiron Technologies Center for Gene Therapy, Digital Gene Technologies, GlySens, Guident, Integra LifeSciences, Innercool Therapies, Isis Pharmaceuticals, Medtronics, Molecular Reflections, Nanogen, the Genomics Institute of the Novartis Foundation, Novatec Laser, Oncosis, Sequenom, Siemens, VitaGen, Xenogenics, and many others. There are over 400 biotechnology and medical device companies in the region, and San Diego's medical device sector is one of the fastest growing in the nation. San Diego boasts the highest number per capita of NIH grants in the nation, totaling over $680 million last year, and was rated best city in quality of life in a survey of life science executives nationwide.

A final word

Advances in science and technology are happening at an impressive pace and will have a fundamental impact on society. The necessary foundation of academic, industrial, government, and public-interest elements is in place. There is a strong demand in bioengineering for a talented workforce, and the need will increase as the field moves forward. The prospects are bright.

1. http://www.whitaker.org.