

# Bioengineer/ Biomedical Engineer

## Snapshot

**Career Cluster(s):** Business, Management & Administration; Science, Technology, Engineering & Mathematics

**Interests:** Inventing; science; medicine; engineering

**Earnings (Yearly Average):** \$91,410

**Employment & Outlook:** Faster Than Average Growth Expected

## OVERVIEW

### Sphere of Work

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Bioengineers and biomedical engineers combine engineering principles with sciences to design and create equipment, devices, computer systems, and software. This can include brand-new inventions, and some engineers may own businesses focused on designing and creating equipment for specialized segments of the market.

### Work Environment

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Bioengineers and biomedical engineers typically work on teams with scientists, healthcare workers, or other engineers, depending on the project. Engineers may be required to travel to locations where their creations are put into use in order to gauge their effectiveness and note opportunities for improvement.



Two female medical engineers examining a piece of equipment.  
Photo via iStock.com/SolStock. [Used under license.]

Most bioengineers and biomedical engineers work full-time, and some work more than 40 hours per week.

### **Occupation Interest**

Bioengineers and biomedical engineers are creative, science-oriented individuals who have a desire to contribute to the scientific and medical field through the creation of new tools and systems. They are able to identify gaps in the current market and have the technical expertise to design new equipment or software to fill those voids. They are eager to apply the latest technological advances towards new creations that will make scientific and medical work faster, safer, and more efficient.

### **A Day in the Life—Duties and Responsibilities**

Bioengineers and biomedical engineers often work in research and development (R&D) or quality assurance.

The work of bioengineers spans many fields. For example, although their expertise is in engineering and biology, they often design computer software to run

### **Duties and Responsibilities**

- Designing equipment and devices, such as artificial internal organs, replacements for body parts, and machines for diagnosing medical problems
- Installing, maintaining, or providing technical support for biomedical equipment
- Collaborating with manufacturing staff on the safety and effectiveness of biomedical equipment
- Working with scientists to research how engineering principles apply to biological systems
- Developing statistical models or simulations using statistical or modeling software
- Preparing procedures and write technical reports and research papers
- Presenting research findings to a variety of audiences, including scientists, clinicians, managers, other engineers, and the public
- Designing or conducting follow-up experiments as needed

### **Profile**

**Interests:** Things, Data, People

**Working Conditions:** Inside

**Education Needs:** Bachelor's Degree; Graduate Degree

**Licensure/Certification:** Usually Not Required

**Opportunities for Experience:** Internship, Co-op

**Interest Score:** IR

complicated instruments, such as 3D x-ray machines. Others use their knowledge of chemistry and biology to develop new drug therapies. Still others draw on math and statistics to understand signals transmitted by the brain or heart. Some are involved in sales.

Biomedical engineers focus on advances in technology and medicine to develop new devices and equipment for improving human health. For example, they might design software to run medical equipment or computer simulations to test new drug therapies. In addition, they design and build artificial body parts, such as hip and knee joints, or develop materials to make replacement parts. They also design rehabilitative exercise equipment.

## OCCUPATION SPECIALTIES

### **Biochemical Engineer**

Biochemical engineers focus on cell structures and microscopic systems to create products for bioremediation, biological waste treatment, and other uses.

### **Bioinstrumentation Engineer**

Bioinstrumentation engineers use electronics, computer science, and measurement principles to develop tools for diagnosing and treating medical problems.

### **Biomaterials Engineer**

Biomaterials engineers study naturally occurring or laboratory-designed substances for use in medical devices or implants.

### **Biomechanics Engineer**

Biomechanics engineers study thermodynamics and other systems to solve biological or medical problems.

### **Clinical Engineer**

Clinical engineers apply medical technology to improve healthcare.

### **Genetic Engineer**

Genetic engineers alter the genetic makeup of organism using recombinant deoxyribonucleic acid (rDNA) technology, such as in developing vitamin-fortified food crops to prevent disease in humans.

### **Rehabilitation Engineer**

Rehabilitation engineers develop devices that aid people who are recovering from or adapting to physical or cognitive impairments.

### **Systems Physiologist**

Systems physiologists use engineering tools to understand how biological systems function and respond to changes in their environment.

## WORK ENVIRONMENT

### **Immediate Physical Environment**

Bioengineers and biomedical engineers work on teams with scientists, healthcare workers, or other engineers. Where and how they work depends on the project. For example, a biomedical engineer who has developed a new device might

spend hours in a hospital to ensure that the device works as planned. If the device needs adjusting, the engineer might need to suggest alterations in the manufacturing process.

### **Human Environment**

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As engineering work is usually a team effort, bioengineers and biomedical engineers must be prepared to collaborate during most projects, and, therefore, must be able to work with colleagues, sometimes from varying disciplines. They may also interact with clients and patients during the design and implementation stages, including on-site testing of equipment. Engineers that own their own businesses have the added responsibility of overseeing their employees in a managerial capacity.

### **Technological Environment**

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Engineers must be able to incorporate the latest technological advances into their work, to further their own creations and better the scientific and medical communities. Nanotechnology, smartphone technology, three-dimensional printing, and artificial intelligence (AI) are all examples of constantly evolving technologies that can play a role in bioengineering. Engineers who own their own businesses must also be well-acquainted with standard business software used for accounting and payroll, for example.

## **EDUCATION, TRAINING, AND ADVANCEMENT**

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### **High School/Secondary**

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In high school, students interested in becoming bioengineers or biomedical engineers should take classes in sciences such as chemistry, physics, and biology. They should also study math, including algebra, geometry, trigonometry, and calculus. If available, classes in drafting, mechanical drawing, and computer programming are also useful.

### **Suggested High School Subjects**

- Algebra
- Biology
- Chemistry
- Civics
- Computer Science
- Drafting

- Earth or Environmental Science
- Economics
- English
- Entrepreneurship
- Geometry
- History
- Physics
- Pre-Calculus
- Psychology
- Statistics
- Trigonometry

### **Related Career Pathways/Majors**

*Business, Management & Administration  
Career Cluster*

- General Management Pathway

*Science, Technology, Engineering &  
Mathematics Career Cluster*

- Engineering & Technology Pathway
- Science & Mathematics Pathway

## **Transferable Skills and Abilities**

### **Analytical Skills**

- Assessing the needs of patients and customers prior to designing products

### **Communication Skills**

- Working with patients and customers and often working on teams
- Writing reports and research papers

### **Creativity**

- Coming up with innovations in healthcare equipment and devices

### **Math Skills**

- Using calculus and other advanced math and statistics for analysis, design, and troubleshooting in their work

### **Mechanical Skills**

- Operating complex machinery and occasionally performing routine maintenance

### **Problem-solving Skills**

- Dealing with intricate biological systems
- Working independently and with others to incorporate ideas into the complex problem-solving process

## **Postsecondary**

At the bachelor's degree level, prospective bioengineers should enter bioengineering or traditional engineering programs, such as mechanical and electrical. Students who pursue traditional engineering degrees may benefit from taking biological science courses.

Bachelor's degree programs in bioengineering and biomedical engineering focus on engineering and biological sciences. These programs typically include laboratory- and classroom-based courses in biological sciences and subjects such as fluid and solid mechanics, circuit design, and biomaterials.

These programs also include substantial training in engineering design. As part of their study, students may have an opportunity to participate in co-ops or internships with hospitals and medical device and pharmaceutical manufacturing companies. Bioengineering and biomedical engineering programs are accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET).

## Fast Fact

Rowland Macy, founder of the department store Macy's, was a serial entrepreneur who failed at seven business ventures before hitting paydirt with his landmark store. Source: lifehack.org



Rowland Macy. Photo via Wikimedia Commons. [Public Domain.]

### Related College Majors

- Biochemical Engineering
- Biological Engineering
- Chemical Engineering
- Computer Engineering
- Electrical Engineering
- Engineering Science
- Materials Engineering
- Mechanical Engineering
- Polymer & Plastics Engineering
- Robotics Engineering

### Adult Job Seekers

Some bioengineers attend medical or dental school to specialize in techniques such as using electric impulses in new ways to get muscles moving again. Others earn law degrees and work as patent attorneys. Still others pursue a master's degree in business administration (MBA) and move into managerial positions.

## EARNINGS AND ADVANCEMENT

Earnings depend on whether the engineer works for or owns the business, and the type and scale of projects undertaken. Median annual earnings of bioengineers or biomedical engineers were \$91,410 in 2019. The lowest 10 percent earned less than \$55,280, and the highest 10 percent earned more than \$148,210.

Bioengineers or biomedical engineers may receive paid vacations, holidays, and sick days; life and health insurance; and retirement benefits. These are usually paid by an employer if the business is not self-owned. Bioengineers or biomedical engineers may also be able to expense travel to on-site locations for product testing.

Bioengineers and biomedical engineers may increase their responsibilities as they gain experience or advanced degrees. To lead a research team, a bioengineer or biomedical engineer typically needs a graduate degree. Those who are interested in basic research may become medical scientists.

## EMPLOYMENT AND OUTLOOK

Bioengineers and biomedical engineers held 21,200 jobs in 2019. Employment is expected to grow faster than average for all occupations through the year 2029, at a rate of 5 percent, because of increasing technologies and their applications to medical equipment and devices. Smartphone technology and three-dimensional printing are examples of technology being applied to biomedical advances.

As the baby-boom generation lives longer and stays active, the demand for bioengineers and biomedical devices and procedures, such as hip and knee replacements, is expected to increase. In addition, as the public awareness of medical advances continues, increasing numbers of people will seek biomedical solutions to their health problems from their physicians.

Bioengineers and biomedical engineers work with scientists, other medical researchers, and manufacturers to address a range of injuries and physical disabilities. The ability of these engineers to collaborate on activities with workers from other fields is enlarging the range of applications for biomedical engineering products and services.

### Related Occupations

- Agricultural Engineer
- Architectural/Engineering Manager
- Biochemist/Biophysicist
- Chemical Engineer
- Electrical/Electronics Engineer
- Materials Engineer
- Mechanical Engineer
- Medical Scientist
- Physician/Surgeon
- Sales Engineer

**MORE INFORMATION****Accreditation Board for Engineering and Technology, Inc. (ABET)**

415 North Charles Street  
Baltimore, MD 21201  
410.347.7700  
www.abet.org

**American Association of Engineering Societies (AAES)**

1801 Alexander Bell Drive  
Reston, VA 20191  
202.296.2237  
orders@aaes.org  
www.aaes.org

**American Institute for Medical and Biological Engineering (AIMBE)**

1400 I Street NW, Suite 235  
Washington, DC 20005  
202.496.9660  
info@aimbe.org  
aimbe.org

**American Society for Engineering Education (ASEE)**

1818 N Street NW, Suite 600  
Washington, DC 20036  
202.331.3500  
www.asee.org

**American Society of Agricultural and Biological Engineers (ASABE)**

2950 Niles Road  
St. Joseph, MI 49085  
269.429.0300  
www.asabe.org

**American Society of Mechanical Engineers (ASME)**

Two Park Avenue  
New York, NY 10016-5990  
800.843.2763  
CustomerCare@asme.org  
www.asme.org

**Biomedical Engineering Society (BMES)**

8201 Corporate Drive, Suite 1125  
Landover, MD 20785  
membership@bmes.org  
301.459.1999  
www.bmes.org

**Engineering Education Service Center (EESC)**

1411 Old Hardman Btms Road  
Clarksville, GA 30523  
706.499.5011  
www.engineeringedu.com

**IEEE Engineering in Medicine and Biology Society (EMBS)**

445 Hoes Lane  
Piscataway, NJ 08854  
732.981.3433  
www.embs.org

**Institute of Biological Engineering (IBE)**

446 East High Street, Suite 10  
Lexington, KY 40507  
859.977.7450  
info@ibe.org  
www.ibe.org

**Society of Biological Engineers (SBE)**

c/o American Institute of Chemical Engineers (AIChE)  
120 Wall Street, FL 23  
New York, NY 10005-4020  
800.242.4363  
www.aiche.org/sbe

**Technology Student Association (TSA)**

1904 Association Drive  
Reston, VA 20191-1540  
703.860.9000  
general@tsaweb.org  
tsaweb.org

## *Conversation With...*

### **RICHARD COTE**

President and Founder, Avidien Technologies, Inc., Hudson, MA  
Product design and development, development management,  
business management, 26 years

#### **What was your individual career path in terms of education/training, entry-level job, or other significant opportunity?**

My father worked as a technical instructor at Massachusetts Institute of Technology, and we had an extensive shop in the basement. So, I was exposed to machine shops and how to put things together. After high school, I spent about 18 months doing different jobs like working on a commercial fishing boat. I also got to the point I could not only take apart a car engine but understand the technical side of it. That led me to want to study mechanical engineering.

While studying mechanical engineering at Northeastern University in the early 1990s, I took advantage of their cooperative education program. In my final co-op assignment, I worked for a company called Costar in Cambridge, Massachusetts, that made life science laboratory equipment and disposable labware.

The exposure in that initial job was the start of my career developing new products used in life science labs around the world. The guy I worked for during my last co-op session offered me a job, and I worked for him or with him for 20 years. He and I moved from one company to another, founded a company, and he is still a good friend.

I was at Costar for about 6 years, then moved to Matrix Technologies. Due to a merger, our parent company was bought. Five of us decided to start a new company, Viaflow Integra. That company is now very successful, but it was both challenging and exciting in the beginning. That experience led me to start my own company, Avidien Technologies Inc. I spent a couple of years doing product development in my spare time while working for another company before launching Avidien full-time.

If you work in chemistry or life sciences, you have to be able to transfer liquids precisely. We make the smallest of a type of automated pipette that is really easy and intuitive to use. Automation reduces mistakes. There are competitors out there, but we developed many concepts that allow these instruments to be small.

We spent 5 years creating the company and designing our product, the first of which was released in 2017. Our clients include pharmaceutical and diagnostic companies, as well as university labs.

Many entrepreneurs have an idea and then go find their funding first. Avidien was bootstrapped, meaning that the company was self-funded through savings, family, and friends. The main reason I was able to afford to bootstrap the company is because I could do a lot of the engineering work myself.

There are many paths that can lead to entrepreneurial pursuits, but for me the cooperative education model followed by direct exposure to the startup environment was the course that led me to where I am today. In addition, most new companies are built around new products, so being an engineer involved in the new product development process before starting Avidien gave me a good foundation on which to build a company.

**What are the most important skills and/or qualities for someone in your profession?**

As an entrepreneur, you have to be willing to take risks and push yourself to keep trying when failure is always a possibility. Above all, the main quality an entrepreneur has to possess is a deep belief in themselves and their ideas.

**What do you wish you had known going into this profession?**

Starting a business requires the founders and early employees to wear many hats—marketing, sales, human resources, accounting, etc. In most jobs people tend to stay in their professional lanes and not pay much attention to the other business functions around them. Through my career I wish that I had paid more attention and asked more questions that in retrospect would have helped me while starting Avidien.

Also, given hindsight, I would tell somebody thinking about entrepreneurship to try it early on. Not so early you don't have enough work experience, but early enough so you're not deep into a mortgage and family. The risk is lower. Also, accept you may fail once or twice but you learn from the failure.

**Are there many job opportunities in your profession? In what specific areas?**

Anyone with the right drive and determination can choose to be an entrepreneur; so, it is not really about job opportunity. However, the key to being a successful entrepreneur is choosing a specific area that is a fit for your skills and your passions, and that is also a marketable endeavor, whether a service, product, or other enterprise.

**How do you see your profession changing in the next 5 years? How will technology impact that change, and what skills will be required?**

In the next five years it will continue to become easier to be a successful entrepreneur. For example, finding your customers is a key aspect to starting a business. As technology advances, reaching potential customers worldwide will continue to evolve into something you can do simply through your computer and internet connection. Success will go to those who develop skills marketing products through the constantly evolving social media platforms and are able to take advantage of that access.

**What do you enjoy most about your job? What do you enjoy least about your job?**

The aspect I enjoy most about being an entrepreneur in a company that develops products for laboratory use is hearing positive feedback about our company's products and service from our customers. Fortunately, this happens frequently. Hearing about a problem a customer is having with one of our products is something I enjoy least. On the positive side, it is also how we learn to improve our products.

**Can you suggest a valuable "try this" for students considering a career in your profession?**

If a student is interested in pursuing a life as an entrepreneur, I would recommend that they work or spend some time in a young startup company to get a flavor for the environment and its challenges. There are also many online and print periodicals dedicated to the aspects of becoming a successful entrepreneur that will paint a bigger picture of what it means to start a company. I also think the show Shark Tank is great for understanding the fundraising component and how investors think about a new venture.