

Identifying Career Opportunities in Agricultural Biotechnology

ARICULTURAL BIOTECHNOLOGY is a worldwide industry, and it is growing. With that growth are opportunities for employment in many interesting careers. People with many different skills and various levels of education are being hired by private agricultural companies worldwide and by public (government-based or -supported) institutions and agencies. Because of the expansion of this industry, increasing your education and experience can also increase opportunities for jobs with more independence and higher salaries.



Objectives:



1. Identify careers associated with biotechnology, and provide a description of each.
2. Identify the types of companies and institutions that provide employment in agricultural biotechnology.
3. Recognize the education and skills necessary to succeed in a career in agricultural biotechnology.

Key Terms:



agricultural experiment station	land-grant institutions	quality assurance engineer
agronomist	media prep technician	regulatory specialist
bioinformatics	molecular biologist	research scientist
biostatistician	patent	technical writer
breeder	pathogens	
entomologist	plant pathologist	
environmental health and safety specialist	product development engineer	

Career Opportunities in Agricultural Biotechnology

With the increase in research and development (R&D) worldwide, there is also an increase in career opportunities in agriculture-based biotechnology. This expanding industry of agricultural biotechnology offers employment for people with varying skills and educational levels. Needed are people with strong scientific and technological expertise, good administrators, and good salespeople with strong communication skills. The careers in biotech can be divided into those that are science related and those that are non-science related.

SCIENCE-RELATED JOBS

Science-related jobs fall into the four categories of (1) research and development, (2) clinical research, (3) manufacturing and production, and (4) quality control.

Research and Development

A **research scientist** is the lead scientist who conducts basic scientific research in a university, government lab, or industry. Many times the research scientist's own ideas for new products have been the impetus that started a company. Research scientists bring specialized expertise and in-depth knowledge in a particular field of science. They are usually responsible for identifying inventions for patents and designing their own experiments. They participate in conferences and contribute writings to scientific journals. They are supported by research associates or assistants who conduct scientific investigations involving data collection, analysis, and interpretation.

Examples of Research Scientists

An **agronomist** is an agricultural scientist who works with plants to solve issues of producing food, creating healthier food, reducing the environmental impact of agriculture, and creating energy from plants. Agronomists use biotechnology to find ways to solve these issues. They may specialize in areas such as plant breeding, weed control, irrigation, and drainage.

An **entomologist** is a scientist who studies insects. Entomologists are heavily involved in developing pest management strategies in biotechnology.



FIGURE 1. A molecular biologist prepares to extract DNA from sorghum plant roots. (Courtesy, Agricultural Research Service, USDA)



ON THE JOB...

CAREER CONNECTION: Molecular Biologist

Dr. Mary Mellin is a molecular biologist and research scientist at a university. Her research team is applying molecular biology techniques to study the genes involved in the formation of cactus plant leaves. These genes may be targets for research to increase drought tolerance in crops. It is exciting work. Dr. Mellin directs her research team of students, associates, and post-doctoral fellows. She especially looks forward to afternoons in the laboratory. At times her job is demanding as she teaches graduate school, attends conferences, stays current by reading scientific literature, and contributes to scientific journals. She says her interest in biotechnology began in college when she was given the opportunity to work as a lab technician by one of her professors. Although she did routine work, such as washing glassware, the experience ignited a passion in her for research. Now, every summer she invites an undergraduate to work in her lab.

A **plant pathologist** is a scientist who studies plant diseases caused by **pathogens** (infectious agents) and environmental conditions that influence diseases.

A **molecular biologist** is a scientist who studies life at the cellular level, merging the fields of genetics and biology. Molecular biologists concentrate on interactions of the cell, focusing on DNA and gene function and expression.

Support for Scientists

Many employees with special scientific skills are needed to support the research that is being conducted by the lead scientist.

A **breeder** is a person who mates carefully selected animals or plants to reproduce special characteristics. Biotechnology animal breeders use artificial insemination (the placing of sperm in the reproductive tract of a female) and embryo transfer (the placing of an embryo in the uterus of a female) to breed livestock. Biotechnology plant breeders use recombinant DNA and RNAi techniques to select plants with certain traits for acceleration of reproduction for product development. A breeder may develop patents and long-range goals for an animal or plant breeding department.

Many technicians are needed to conduct experiments, depending on whether plants or animals are being used. A **media prep technician** is a person who prepares media for biological cultures and maintains records to track experimental procedures. A greenhouse assistant is responsible for monitoring and maintaining optimal conditions for plants growing in a greenhouse. The operations of the greenhouse might also be this person's responsibility. An animal caretaker attends to any animals in the manufacturing process.

Clinical Research

A clinical research administrator or coordinator is responsible for data entry and validation. Clinical research administrators or coordinators may work with medical or veterinary physi-

cians during clinical trials to clarify questionable events. They may also be responsible for auditing. They coordinate the development plan, schedule, and provide updates on progress.

Support in the clinical setting involves additional employees. A clinical data specialist is responsible for collaborating with many departments to organize clinical data studies and report trends of data sets. A **biostatistician** is a person who analyzes databases and prepares reports for publications.

An animal handler takes care of experimental research animals on a daily basis. He or she cleans animal cages and grooms and observes the animals. An animal technician also takes care of research animals on a daily basis. He or she may perform surgery, oversee animal supplies, and observe animal health. An animal technician maintains records and follows regulatory requirements.

A **technical writer** is a person who writes and edits standard operating procedures, protocols, and lab procedure manuals and complies with regulations in all documentation.

Manufacturing and Production

Workers in manufacturing and production actually make the products or deliver the services that a company sells. Scientific, engineering, industrial, and mechanical skills are needed. Detailed reports are produced by these employees.

Depending on the company or institution, the jobs can vary greatly.

A **product development engineer** is a person who designs, develops, and enhances existing products and processes. Good labor and manufacturing practices are a responsibility. There may also be contact with outside vendors.

A production planner makes sure deadlines are developed and production stays on schedule to produce the final product. He or she also keeps management informed of progress.

A manufacturing engineer or technician monitors the product from start to finish, including packaging and the estimation of production costs.

An instrumentation technician calibrates, maintains, and trouble-shoots equipment needed in production.

Quality Control

A **quality assurance engineer** is a person who monitors the entire production process to make sure good manufacturing and standard operating procedures are followed at all times.

An **environmental health and safety specialist** is a person who develops and monitors safety programs. He or she inspects plant areas, new equipment, and raw materials and monitors exposure to possibly toxic substances.



FIGURE 2. These two researchers are conducting a manufacturing experiment.

NON-SCIENCE-RELATED JOBS

The people in these jobs carry out many different functions in the day-to-day operation of a company or institution.

Information Systems

Bioinformatics is a science that combines biology, computer science, and information technology into a single discipline. Computer specialists trained in bioinformatics manage the massive amount of biological information found in data banks.

Marketing and Sales

Market researchers assess the need for a product, the number of people who will most likely buy it, and the price they would be willing to pay. Marketing personnel find new markets and seek new ways to advertise and promote products. Salespeople deal directly with selling products to customers. They are representatives of their company. They relay feedback from the customers to their company.



FIGURE 3. Market research is necessary to find out whether a new product is desired by consumers.

Regulatory Affairs

A regulatory affairs specialist prepares documents for submission to regulatory agencies and for inspections and recommends strategies for the earliest possible approval of trials. A **regulatory specialist** is usually a person with scientific background who keeps track of all the federal and state regulations that apply to the company and makes sure the company complies with them.

Legal Affairs

Legal specialists prepare and track patent applications. A **patent** is a set of exclusive rights given to the owner to market a new invention for a certain length of time, eliminating the possibility of a competitor making the same product. Patent attorneys are attorneys who specialize in patent law.

Public Relations, Communications, and Training

Public relations personnel are effective communicators to the public. Technical writers write internal or external reports that are easy enough for the lay public to understand. Trainers organize and conduct technical training, usually within the company.

Management and Support

Managers organize and supervise activities. Many start out as scientists or engineers and work their way up. Support personnel are also required. They include administrative assistants, accountants, information management specialists, and computer technicians.

Companies and Institutions That Provide Employment

Agricultural biotechnology employment opportunities are available in private companies and in public (government-based or -supported) institutions and agencies.

PRIVATE BIOTECH COMPANIES WORKING WITH CROPS

The following companies, which are among the top private employers in plant agricultural biotechnology, have formed the Council for Biotechnology Information. Three of them are headquartered in the United States, and three of them are based in Europe.

- ◆ BASF Plant Science, headquartered in Limburgerhoff, Germany, is involved in plant biotechnology. It has eight sites in five countries of Europe and North America and employs about 700 people. Efforts of BASF Plant Science are in more efficient agriculture, renewable raw materials, and healthier nutrition for humans and animals.
- ◆ Bayer CropScience is headquartered in Monheim, Germany. It is involved in crop protection, nonagricultural pest control, seeds, and plant biotechnology. Bayer CropScience offers products for modern, sustainable agriculture and for nonagricultural applications.



FIGURE 4. A disease on corn plants is being inspected. (Courtesy, Agricultural Research Service, USDA)

- ◆ Dow AgroSciences LLC, based in Indianapolis, Indiana, provides technologies for crop protection, pest and vegetation management, seeds, traits, and agricultural biotechnology.
- ◆ DuPont's Pioneer Hi-Bred business is headquartered in Des Moines, Iowa. It provides access to advanced plant genetics in nearly 70 countries. Pioneer Hi-Bred offers customized solutions for farmers, livestock producers, and grain and oilseed processors.
- ◆ Monsanto Company is headquartered in St. Louis, Missouri, and is focused on agriculture and the success of farmers. Its technology-based solutions and agricultural products improve farm productivity and food quality through plant breeding, plant biotechnology, and other applications of modern science to agriculture.
- ◆ Syngenta is based in Basel, Switzerland. Its goal is to provide sustainable agriculture through innovative research and technology. Syngenta is involved in crop protection and high-value commercial seeds. The company employs over 21,000 people in more than 90 countries.

Cargill is a leading private employer in plant agricultural biotechnology. Based in Minneapolis, Minnesota, the company employs 159,000 people in 68 countries. It is involved with producing biofuels and feed stock for animals.

PRIVATE BIOTECH COMPANIES WORKING WITH ANIMALS

Private companies that provide products and services in animal agricultural biotechnology are diverse. Here are descriptions of a few of them.

Select Sires, in Ohio, is a company that provides services in dairy and beef cattle genetics. It prepares semen and embryos for breeding.

Advanced Cell Technology (ACT) has cloned cows. It is also researching ways to prevent the rejection of cells transferred from one living organism to another (immune rejection). ACT, like many facilities, uses animal models to pursue its research. The company's headquarters are in California, with laboratory facilities in Massachusetts.

Genencor is involved in developing eco-friendly enzyme products used in the agricultural processing of food, feed, and biofuels. It is based in Rochester, New York. Genencor employs 1,474 people in more than 80 countries.

PUBLIC (GOVERNMENT-BASED OR -SUPPORTED) INSTITUTIONS AND AGENCIES

Land-grant institutions are a group of U.S. agricultural colleges and universities formed through legislation back in 1862. They were given land on which to build their schools, and in exchange they offered practical subjects, such as farming, to the public. Today, they conduct research in agricultural biotechnology and make the information about biotechnology available to the public. Iowa State University was the first land-grant university. There are currently almost 60 colleges and universities, where many people are being employed in scientific research in agricultural biotechnology.



FURTHER EXPLORATION...

ONLINE CONNECTION: Locating Biotech Companies in the United States

Go to the Biotechnology Industry Organization's report at http://bio.org/local/battelle2008/State_Bioscience_Initiatives_2008.pdf to see how well agricultural biotechnology companies are doing. The information you will find will include graphs showing the agricultural biotech companies in the United States. Analyze the graphs, and you will be able to assess how well your state is represented and where the top companies are located.

An **agricultural experiment station** is a government-supported research center or field laboratory that conducts scientific investigations in animal and plant sciences. There are more than 50 facilities in the United States. Their goal is to solve problems and suggest improvements in agriculture that are of practical concern to U.S. citizens. They were formed in conjunction with, and are an extension of, land-grant institutions. Employees work directly with farmers, ranchers, and suppliers in the field. Agricultural experiment stations provide a testing ground for proof of concept research by college faculty. They also provide hands-on learning for undergraduate and graduate students. Principal investigators, research assistants, and animal and plant technicians work at these facilities.

The U.S. Department of Agriculture employs people who are knowledgeable in agricultural biotechnology. Extension Services inform people about current developments in agriculture and related subjects. The facilities are operated by land-grant universities. Many divisions, such as the Agricultural Research Service (ARS) and the Food and Safety Inspection Service (FSIS), are highly involved in the production and regulation of biotech animals and crops.

Education and Skills Necessary to Succeed

There are many jobs in biotechnology starting at a high school entry level. Many companies, however, provide incentive or reimbursement for additional schooling. By increasing your education and experience, you can acquire more responsibility, more independence, and a higher salary.

HIGH SCHOOL DEGREE

A high school diploma or a GED (General Education Development) certificate is required for



FIGURE 5. Education is required to succeed in the field of biotechnology.

entry-level positions, such as laboratory assistants. There is usually on-the-job training for routine experimental operations, such as preparing solutions and media, taking care of lab animals or greenhouse plants, and washing glassware.

TWO-YEAR DEGREE

A two-year Associate of Applied Science (A.A.S.) degree is required for many production and quality control jobs. Because of the many lab experiences in biotechnology programs, graduates from technical colleges usually have an edge for employment.

FOUR-YEAR DEGREE

A four-year bachelor's (B.S. or B.A.) degree is required for research associates and more technical positions, such as specialized technicians, technologists, manufacturing or production assistants, product development engineers, and quality control analysts. Biotechnology technicians usually have a B.S or M.S. degree in a related science area. Their jobs vary depending on the place of employment. Earning a degree in the physical or biological sciences is very helpful. Suggested areas are general biology, genetics, biochemistry, microbiology, botany or zoology, molecular and cellular biology, chemistry, chemical engineering, environmental science, toxicology, pharmacology, computer science, agricultural science, sales, and marketing. It is also helpful for future employment to secure summer jobs in industry or on research projects while a student.

ADVANCED DEGREES

A master's degree offers the same opportunities as a bachelor's, but the pay is more, and advancement to a supervisory position is more likely.

A doctoral degree—Doctor of Philosophy (Ph.D.), Medical Doctor (M.D.), or Doctor of Veterinary Medicine (D.V.M.)—offers a career in basic scientific research. Research scientists design research processes and direct the activities of bachelor's and master's employees. Positions include research scientist, senior scientist, principal scientist, research or scientific director, and vice-president for research.

SKILLS

Technical skills required in agricultural biotechnology include basic laboratory skills, knowledge of



FIGURE 6. Basic laboratory skills are among the technical skills required in agricultural biotechnology.

universal biological lab techniques (cloning, media preparation, and sterile technique), safety skills, quality control skills, and instrument analysis skills.

General employability skills required are reading, writing, speaking (being an effective communicator), mathematical and statistical skills, computer skills, and interpersonal skills.

Related job skills that promote employment are technical writing skills, problem-solving skills, and mechanical aptitude. People applying in sales and marketing have an edge if they also have a background in science education.

Summary:



With the increase in research and development (R&D) worldwide, there is also an increase in career opportunities in agriculture-based biotechnology. People with strong scientific and technological expertise, administrator skills, and good sales skills are needed for this growing industry. Employment opportunities for people with varying skills are available both in the United States and in other parts of the world in private companies and in public (government-based or -supported) institutions and agencies. Jobs at the high school entry level are available, but many companies provide incentive or reimbursement for additional schooling. By increasing your education and experience, you can acquire more responsibility, more independence, and a higher salary.

Checking Your Knowledge:



1. What are three types of science-related jobs available in agricultural biotechnology?
2. What are three types of non-science-related jobs available in agricultural biotechnology?
3. What are the names and locations of two companies involved in plant biotechnology?
4. What are the names and locations of two companies involved in animal biotechnology?
5. What role do land-grant universities play in career opportunities in plant or animal biotech?
6. What kinds of basic science skills are needed to work in agricultural biotechnology?

Expanding Your Knowledge:



Visit an agricultural biotechnology company or institution, and ask to speak to the human resources person. Find out what positions are filled by employees with vari-

ous degrees. Ask if you may speak with someone at the facility who is in a position that interests you. Suggest a possible job shadow for a day if the company or institution is willing.

Web Links:



An Insider's View of Corporate Plant Biotechnology

http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2002_11_01/noDOI.6007702385213971586

Cornell University's New York State Agricultural Experiment Station

<http://www.nysaes.cornell.edu/>

The Mathematical Biology Job Market

http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2004_02_27/noDOI.6305720559640560046

Agricultural Career Profiles

<http://www.mycaert.com/career-profiles>