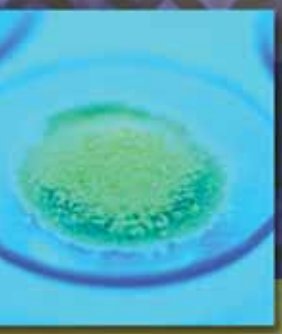
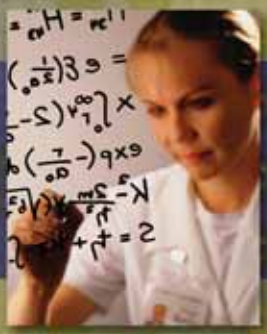
BIOTECHNOLOGY EDITION

CAREER PATHWAYS

A guide for students, parents, and educators in North Carolina





Focus on BIOTECHNOLOGY

- Work with your hands and your mind
- Work with new ideas and new products
- Work in many careers and build your future

Biotechnology: An Industry for the Future

Environmental technicians at Novozymes North America in Franklinton, North Carolina, recycle nutrient-rich waste from manufacturing processes, spreading it in carefully controlled amounts as fertilizer on nearby fields. In the biotech future, more and more industrial chemical processes will rely on renewable resources instead of petroleum.

OPPORTUNITIES

Education for Biotechnology Opens Many Doors

In North Carolina, there are now nearly 20,000 people working in biotechnology companies. In addition, approximately 60,000 more are working in traditional chemical and pharmaceutical companies and specialty firms that provide services such as clinical trials management or engineering. All these companies may employ people with similar education and training in science, engineering, or manufacturing technology.

Completing a specialized biotechnology program at a community college or university opens many doors. Upon graduation, you will likely have many employment opportunities in the biotechnology industry, and in a broad group of bioscience and chemical companies employing individuals with similar sets of skills.

"...it is important to remember that biotech is the one industry that's poised to grapple with every major human and environmental challenge, from global hunger to global warming..." — G. Steven Burrill, *Biotech 2003 (Life Sciences: Revaluation and Restructuring)*

What Is Biotechnology?

It's in the news a lot and, because North Carolina is one of the nation's leading states in biotechnology, you may have seen headlines about new companies and jobs. But in fact, biotechnology has been around a long time.

Traditional biotechnology was (and still is) the use of living organisms to solve problems and make useful products. Domesticating crop plants and farm animals through selective breeding, and using yeast to make bread rise and produce wine are examples of traditional biotechnology.

New biotechnology: the use of living cells and their molecules to solve problems and make useful products.

New biotechnology is based on scientific advances over the last 50 years that have enabled us to understand how living organisms work—and how they can work for us. The key knowledge is an understanding of cells, the basic units of life, and—at a still deeper level—the molecules that make up cells.

Now, our understanding of how cells work makes it possible to create new varieties of plants with better nutrients for our diet, and the traditional fermentation processes used to make wine or beer have been re-tooled to produce cutting-edge pharmaceuticals for previously incurable diseases.

Biotechnology in Industry

When we use the term "biotechnology company" in this publication, we mean a company that uses biotechnology tools in its work. Since these tools can be used wherever living things are involved—and even where you might not think living things are involved—there is a broad range of industries where you might work in biotechnology.

You might work in:

- A pharmaceutical company developing new ways to cure cancer
- A chemical company making plastic from corn instead of petroleum
- An environmental company finding new microorganisms to clean up oil spills
- An agricultural company developing drought-resistant crops
- An energy company using fermentation to make ethanol for fuel.

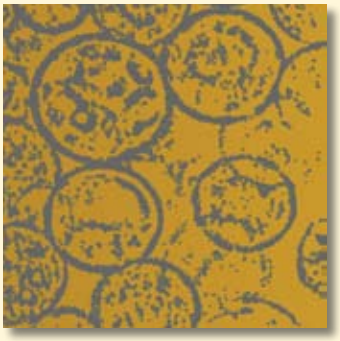
A process technician inspects a bioreactor used to grow cells that produce a pharmaceutical product.

A laboratory associate at Talecris Biotherapeutics in Clayton, North Carolina, works to optimize a step in the manufacturing process. Talecris purifies proteins from human serum for therapeutic use.

Biotechnology's Toolbox

Biotechnology is not just one technology, but many. Biotechnology is a toolbox filled with many different kinds of living cells and their component molecules, and different ways to use them. Because there are millions of different species of plants, animals, and microorganisms in the world, each having cells and molecules with unique characteristics, there are a lot of potential tools in this toolbox! This is why biotechnology is so powerful and can be applied in so many different ways.

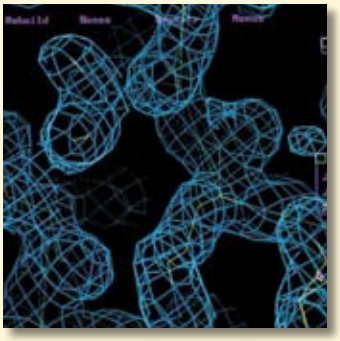
There are three basic kinds of biotechnology tools.



1. Working with Cells

A cell is the smallest unit of life. Some organisms (like yeast) have only a single cell; animals and plants can be made up of billions of cells. A typical human cell is less than a tenth the size of the period at the end of this sentence. Yet a single cell contains billions of molecules of many different kinds. You can think of a cell as a tiny chemical plant in which thousands of chemical reactions are going on every minute. This complex chemistry is what makes cells useful. For example, we can use chemical reactions in cells to break down pollutants or to synthesize antibiotics to cure infections.

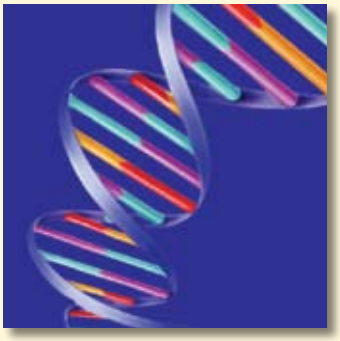
While a single cell can't produce enough of a product such as an antibiotic to do any good, we can grow billions of cells in bioreactors. This is called bioprocessing, and people who work in this field need to know biology, engineering, and manufacturing technology.



2. Working with Proteins

Many of the molecules in cells are proteins. These are the molecules that actually do the chemical work inside a cell and make it useful. Many of these proteins are enzymes. Even a simple cell such as a bacterium contains about 2,000 different proteins, each one with a unique job. When we use cells in a particular way—for example, to clean up an oil spill—we are actually using the enzymes made by the cells.

When we grow cells to make a useful product, the product is often a protein molecule. Protein products range from the enzymes added to laundry detergents, to insulin for diabetics, to vaccines used to prevent disease. Chemists, biochemists, and molecular biologists study the intricate structure of protein molecules and develop new ways to use these molecules.



3. Working with Genes

You probably know that DNA is the molecule responsible for inheritance. And you know from crime shows on TV that parts of our DNA molecules are unique to each individual. The sequences of chemical building blocks strung together to make up a DNA molecule are instructions, or blueprints, for a cell. These instructions, or genes, tell the cell how to make each of its proteins.

The DNA instructions are "written" in a chemical language called the genetic code. Because we have also learned how to change the code in DNA molecules, we can give a cell new instructions, telling it how to make the protein we want or how to do some other job. This is called genetic engineering. For example, geneticists have inserted the gene for a human protein called interferon into hamster cells that can be grown in bioreactors. The interferon is used to treat multiple sclerosis.

Biotechnology at Work

Because biotechnology can be used by many different companies, people who pursue the appropriate education, training, and skills to work in biotechnology will have many exciting career options.

Many industries are finding uses for the new tools provided by biotechnology. The health care industry is developing better ways to diagnose, treat, and prevent disease. The food and agriculture industries are rapidly adopting the tools of biotechnology. The "third wave" of biotechnology applications is just beginning to emerge in energy and the environment, where living cells and their molecules can help us develop new methods to clean up our environment, detect environmental contamination, and reduce our dependence on petroleum.

In addition to industry, biotechnology's toolbox is utilized in university research institutions and government agencies, such as the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), the National Institutes of Health (NIH), the Department of Agriculture (USDA), the Federal Bureau of Investigation (FBI), and similar state agencies.

And There's More...

- Forensic scientists use DNA analysis and other biotechnology tools to solve crimes.
- Scientists around the world are collaborating to store DNA samples of endangered species and preserve the biodiversity that would be lost if these species became extinct.
- A protein that can absorb and degrade chemical nerve agents could become a new defense against bioterrorism.

Many beneficial applications of biotechnology are outlined in this publication. Nonetheless, some applications remain controversial. Throughout history, people often have been uncomfortable with new technologies. While technologies are not in themselves good or bad, sometimes a *particular application* of a technology concerns people. They may conclude that all applications of a specific technology are bad, overlooking many cases in which it can do great good. Before making decisions about a particular application, it is important to carefully study the scientific facts, the economic, sociological, and environmental balance of risks and benefits, as well as other ethical or legal issues that may be involved.

FIGHTING DISEASE

FASTER DIAGNOSIS: Biotechnology has made it possible to diagnose strep throat in minutes, rather than days. Some types of cancer can now be diagnosed with a simple blood test, rather than surgery.

NEW TREATMENTS: Biotechnology delivered the first new treatment for multiple sclerosis in over 20 years and the first new therapy for cystic fibrosis in over 30 years. In the future, defective genes or damaged cells may be repaired or replaced through the use of biotechnology.

BETTER PREVENTION: New vaccines help prevent hepatitis, meningitis, and influenza. New vaccines in food may eliminate the need for a trip to the doctor and a shot.

Protecting Babies And Children

Wyeth Vaccines, a business unit of Wyeth Pharmaceuticals, is dedicated to making life-saving vaccines, including those that eliminated smallpox and polio from the United States. Their Sanford, North Carolina, facility is continuing this legacy.

In the last decade, Wyeth's vaccines for meningitis, pneumonia, blood infections, and bacterial infections have significantly reduced infant and childhood mortality from these diseases around the world. Since Wyeth introduced its pneumonia vaccine for infants and toddlers, the incidence of the disease in children under two has declined by almost 80%.

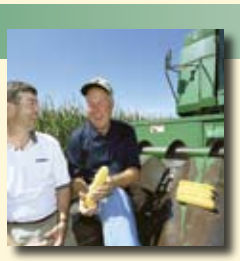
Approximately 1,500 people work at Wyeth's 325,000-square-foot facility in Sanford.

FEEDING THE WORLD

HARDIER CROPS: Innovative biotechnology solutions are creating crops that are more resistant to insects, diseases, and harsh weather, increasing U.S. farm income by more than $1.5 billion a year.

HEALTHIER ANIMALS: Biotechnology-engineered vaccines are available for parasites and infectious diseases. In the future, it may be possible to breed animals naturally resistant to parasites and disease.

BETTER FOOD: One of the first biotechnology foods was a tomato that could ripen on the vine for better flavor and still remain firm for shipping. Biotechnology can make food safer by reducing naturally-occurring toxins and allergens, as well as enhancing nutrient content and flavor.



Helping Farmers Prosper

Syngenta Biotechnology is a division of an international agricultural company committed to sustainable agriculture.

Sustainable agriculture combines different methods to make agriculture both profitable and environmentally sound. By helping farmers get more out of their existing farmland through improved crops, Syngenta's products help farmers remain profitable while preventing deforestation.

Syngenta Biotechnology has developed a new type of corn that resists the corn borer, one of the most destructive crop pests in the world. It also markets soybeans that reduce the cost and environmental impact of weed control. The company employs approximately 250 people in Research Triangle Park, North Carolina.

SAVING OUR ENVIRONMENT

NEW FUELS: New "designer" enzymes from biotechnology labs are being used to manufacture bioethanol, a non-polluting fuel made from plant material that can be used in place of gasoline. Using renewable resources such as corn or agricultural waste to produce a cleaner fuel is a win-win benefit for the environment.

CLEANER AIR, WATER, AND SOIL: Plants and bacteria can be used to safely clean up oil spills and remove toxic chemicals and other pollutants from our air, water, and soil.

NEW MATERIALS: Researchers have genetically engineered cells so that they can use plant sugars instead of petroleum-based chemicals to create biodegradable plastics and polyesters. "Green plastics" made from corn are being used to manufacture packaging materials, clothing, and bedding.

Enabling Cleaner Manufacturing

Novozymes North America, Inc. uses environmentally friendly manufacturing processes to make environmentally friendly products. Novozymes harnesses the chemical productivity of microorganisms through fermentation to create over 600 enzyme products, many of these at its facility in Franklinton, North Carolina. These products are used in industry worldwide for everything from processing cotton to making "stone-washed" denim to brewing beer and treating wastewater.

Novozymes products used in treatment of cotton textiles result in a 25 percent to 30 percent reduction of the process's impact on the environment by lowering energy consumption and the release of acid wastes. In 2005, Novozymes received the Environmental Protection Agency's (EPA) Presidential Green Chemistry Challenge Award for their innovative use of biotechnology to make healthier fats and oils.

Novozymes employs about 400 people at its facility in Franklinton.

A Career with Many Choices

Biotechnology offers a wider range of career choices than many other fields. You can choose among different types of employers, different roles within an organization, different work environments, and different paths for future advancement.

Salaries

Whatever career path you choose, you can often earn a higher salary if you pursue that career in the field of biotechnology. That's because biotechnology companies often pay competitive salaries to attract and retain employees who have the specialized knowledge and skills they require. The career profiles on pages 10 through 21 provide information on salaries for specific careers in biotechnology.

A packaging technician in a clean room visually inspects vials for potential defects before they are filled with a sterile injectable pharmaceutical product.

A Choice of Employers

The knowledge and skills required for a job in biotechnology are highly transferable. In industry, you can work for a pharmaceutical, medical device, food, agricultural, or chemical company. You might also work for a government agency or in a university.

A Choice of Work

Biotechnology careers have expanded well beyond the research laboratory as innovative ideas move to practical applications in the marketplace. Today there are many different jobs you can do in a biotechnology or related bioscience company:

- As a scientist, you can research the structure of a human protein involved in disease.
- As a laboratory technician, you can do exciting experiments to learn about that protein.
- As an engineer, you can design, build, or supervise a biomanufacturing facility to make this new product.
- As a process technician, you can operate a three-story-high bioreactor growing thousands of gallons of cells that make the new protein.
- As a facilities technician, you can troubleshoot and repair equipment malfunctions to keep the process running smoothly.
- As a clinical research associate, you can oversee a large clinical trial to investigate the safety of this new pharmaceutical.

A Choice of Environments

Jobs are available in many different types of industries, companies, and organizations:

- You can work in a fast-paced business environment, a cutting-edge research lab, a high-tech manufacturing facility, or in a greenhouse or agricultural research station.
- You can work exclusively at one location or travel—even globally—on a regular basis to meet with customers or inspect manufacturing operations.
- You can wear a business suit, lab coat, protective gear, clean room gown, or coveralls and work boots.
- You can work a traditional 9-to-5, Monday-through-Friday schedule or work on different shifts.
- You can work in a city or small town. Biotechnology is a global industry—you can work anywhere in the world.
- You can work in a classroom educating future scientists and technicians.
- You can work mostly with your head to generate new ideas or solve problems; mostly with your hands to operate or fix things; or you can use mind and hands more or less equally.

A Choice of Futures

Because biotechnology is an evolving field, it holds excellent promise for long-term career growth:

- You can advance by pursuing a management position. Most employers offer two tracks for advancement. Technical managers are senior technical or scientific experts who manage technical activities. Corporate managers become more involved in the business side of the company.
- You can advance by obtaining additional education. Biotechnology requires life-long learning. You can pursue certification in a specific technical competency, or you can expand your knowledge more broadly by pursuing a higher degree. Community colleges and universities in North Carolina make it easy to get education part-time through distance learning, short courses, and degree programs tailored to the working adult.
- You can advance by moving from one type of job to another, within a company, or from one company to another. You can even move from industry to a government agency or educational institution, and vice versa.

How Biotech Products Are Made

From Laboratory to Market

In the preceding pages, you've seen the wide range of biotechnology products that are possible. But even though such products may be very different, most companies making a biotechnology product operate in a similar way. We'll look at the pharmaceutical industry as an illustration of the major functions involved in the discovery, development, and marketing of a new product.

Making a New Drug

A unique feature of the pharmaceutical industry is that it is tightly regulated by the Food and Drug Administration (FDA). This means that all employees, from top management on down, have to comply with regulations called Good Manufacturing Practices (GMPs). These regulations require disciplined attention to following standard operating procedures and documenting every step in the manufacturing process. Working in a GMP facility requires patience and attention to detail, but successful employees appreciate the need for strict controls when making products that affect people's lives.

A Summary of Job Roles and Responsibilities

The descriptions on the page at right provide a summary of the activities involved in each step of the process of making a pharmaceutical. Within these descriptions, a number of career areas are indicated in boldface. The pages that follow provide additional information on each of these areas:

- **Scientists** (pages 10-11)
- **Laboratory Technicians** (pages 12-13)
- **Engineers** (pages 14-15)
- **Process Technicians** (pages 16-17)
- **Maintenance and Instrumentation Technicians** (pages 18-19)
- **Corporate Scientific Professionals** (pages 20-21)

The roles of these employees in other kinds of companies making different products are in many cases similar to those described on the page at right.

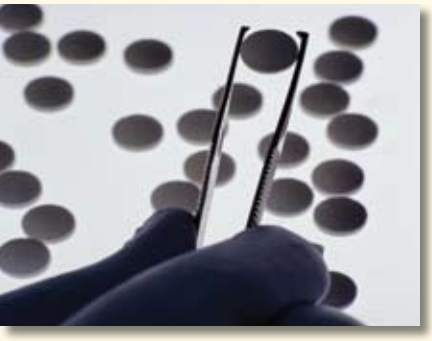
Process technicians at Diosynth Biotechnology prepare a bioreactor. By providing a controlled environment, a bioreactor is a life support system for the cells that grow within it.

1. Discovering and Developing a New Biotechnology Drug

A new product begins in the research laboratory, where **scientists** and **laboratory technicians** use biotech tools to learn about the causes of disease. Their discoveries lead to new ideas about how to combat disease. For example, a type of protein called an antibody might be a cure for a particular disease. Many different antibodies are then tested to see which one works best. Now various **corporate scientific professionals** get involved. *Patent attorneys* ensure the new drug idea is protected from competitors. *Medical and clinical personnel* design and conduct clinical studies to evaluate the safety of the new drug in patients while *regulatory experts* obtain FDA approval to market the new drug. *Marketing and business executives* evaluate its profitability. This whole process takes years.

2. Preparing to Make a New Drug

The processes used to make small quantities of drugs in a laboratory don't work to make the large quantities that will be sold. **Engineers** work with **process technicians**, **scientists**, and **laboratory technicians** to develop a large-scale manufacturing process for the new drug. In some cases, **engineers** must design and oversee construction of a new plant. Once the plant and equipment are ready, FDA regulations require everything be tested to make sure the system will produce a drug to meet set standards. This is called *validation*, and requires the expertise of specialists in this field as well as **engineers**, **technicians**, and **scientists**.



3. Making a New Drug

Process technicians operate all the equipment required to make the new product. To make this antibody, they grow cells in huge stainless steel tanks surrounded by a maze of piping, pumps, and automated control hardware. **Engineers** supervise the process. **Maintenance and instrumentation technicians** keep the plant systems and equipment running smoothly. **Laboratory technicians** test samples of the drug and the manufacturing environment to make sure that the drug produced is safe and meets all standards. **Scientists** often assist experienced manufacturing teams to solve problems or improve the process.

4. Getting the New Drug to Patients

Corporate scientific professionals play leading roles in getting the new drug to the patients who need it. *Medical writers* prepare the drug labeling and other information to be used by physicians and patients. *Sales and marketing professionals* are responsible for marketing the new drug and assessing the extent to which it meets physician and patient needs. *Regulatory experts* ensure that the company's sales and advertising practices comply with FDA regulations. *Technical sales and customer service personnel* work with physicians and patients who have questions or problems with the new drug. **Scientists** continue to look for ways to improve the drug.

5. Ensuring Patient Safety

While ensuring patient safety is a critical part of every step described above, **corporate scientific professionals** also play important roles in ensuring patient safety even after the product is in a customer's hands. *Medical and clinical personnel* evaluate the safety of the new drug and review reports of side effects submitted by physicians once the product is on the market. *Regulatory experts* ensure that side effects are reported to the FDA. **Scientists** and **laboratory technicians** monitor drug quality to ensure that no changes have occurred to the new drug that might affect its safe use by patients.

Spotlight on Scientists

A scientist at Novozymes North America works to find new uses for the company's existing line of industrial enzymes. These enzymes are used in baking, brewing, textile processing, and in many other applications.

A scientist at Biogen Idec uses sophisticated computer software to examine the molecular structure of a protein.

ON THE JOB

Work Environment

Scientists with expertise relevant to biotechnology are found in many different work environments. They work for pharmaceutical, agricultural, chemical, and other companies. They work for government agencies that perform forensic analysis, food and drug product approvals, and environmental testing. Scientists are also employed by universities and colleges to conduct research and teach.

Although most scientists spend a fair amount of time in laboratories, many people don't realize how much more time they spend in offices thinking and writing. An experiment that takes one day to complete might produce data that takes a week to analyze. And research results—no matter how exciting—aren't worth much if they aren't communicated to other scientists or to management. Writing and presentation skills are critical to success. Scientists might come to work in jeans, or "business casual" attire or suits, depending on the organization they work for, and put on a lab coat, safety glasses, and other light protective wear when they need to go into the laboratory.

Salary and Advancement*

In North Carolina, average salaries for scientists are usually around $67,000. Starting salaries for an entry-level scientist typically run about $46,000. More experienced scientists can earn $78,000 or significantly more, depending on how much education and experience they have. As these figures do not reflect specific educational levels or types of companies, actual salaries may be higher or lower.

The salary figures above identify a range for positions similar to those outlined for scientists in this publication. Earning potential becomes greater as an individual's career progresses. Scientists often move out of laboratory science and into upper management or other positions as corporate scientific professionals (regulatory affairs, quality assurance, sales, and marketing).

**Salary ranges compiled from North Carolina data obtained from the U.S. Department of Labor's Bureau of Labor Statistics.*

"In high school, I wanted to be a doctor. In college, I found I enjoyed scientific research more and decided I could help people by developing new drugs. It's enormously rewarding not only to apply my knowledge in new ways, but to see the difference we can make in patients' lives." – **Bill**

A Scientist at Work

Bill is a product development scientist at a biopharmaceutical company developing new treatments for asthma. He joined the company after working for the U.S. Food and Drug Administration (FDA) for four years. He has a B.S. in biochemistry and a Ph.D. in pharmacology.

Bill designs experimental studies to evaluate potential new drugs and the processes to manufacture them. He reviews and analyzes laboratory results, writes reports, and makes recommendations to management about the drugs that seem most promising, and whether it's going to be practical to produce them commercially. He has three technicians who do most of the hands-on laboratory work.

Bill works a busy 40-plus-hour week, sometimes staying late or coming in on the weekend to finish an important report. He spends much of his time in his office, analyzing data from experiments, designing new experiments, reading the latest scientific literature, and writing. He spends the rest of his time in the laboratory with fellow scientists and technicians, often in lively discussions that generate new ideas. He also spends time in company meetings outside the lab. While he sometimes wishes he could spend more time in the lab doing experiments, he enjoys explaining his work to the non-scientists in business or engineering divisions of the company, and learning about what they do. He expects this can lead to new career options for him.

Specialty Disciplines

Scientists who pursue graduate education in North Carolina have a wide variety of possible academic disciplines to pursue and then practice upon graduation. Disciplines include:

- Agricultural Science
- Biochemistry
- Bioinformatics
- Biostatistics
- Botany
- Cell Biology
- Chemistry
- Epidemiology
- Food Science
- Functional Genomics
- Genetics
- Immunology
- Marine Biology
- Microbiology
- Molecular Biology
- Pharmacology
- Physiology
- Plant Pathology
- Toxicology
- Virology
- Zoology

CAREER MAP: SCIENTIST

Scientists have an in-depth knowledge of a scientific area such as biochemistry, cell biology, genetics, or toxicology. Scientists in industry may design studies to evaluate or improve products or processes, develop tests to ensure product quality, or explain the scientific aspects of products or processes to regulators, customers, or investors. Scientists in government may conduct research, make recommendations for product approvals or scientific policy, or do forensic investigations. Scientists at large research universities teach and conduct research; at smaller institutions, their primary responsibility is teaching. If you are always asking why, are intrigued by puzzles or mysteries, and have a thirst for knowledge, you would probably enjoy being a scientist.

Secondary Career Development Schedule

Science course sequences may vary by school. All students are encouraged to take any available higher-level mathematics and science courses, beginning in middle school. Courses in business, computers, and communication are valuable to develop necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Higher-Level Math *(Algebra II prerequisite)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principals of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Second Language	Second Language	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science *or* Mathematics Elective	Advanced Science *or* Mathematics Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for scientists. **Agriculture**: Biotechnology and Agriscience Research I & II; Horticulture I & II; **Food Science**: Foods II–Foods Technology; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Biotechnical Engineering specialty course); **Health Sciences**: Biomedical Technology, Medical Sciences I & II. In addition, Advanced Studies courses with a biotechnology focus are encouraged in all of these areas.

North Carolina Postsecondary Options

Community College Programs

Students completing Associate of Science (A.S.) degree programs in chemistry, biology, or physics can continue their education at four-year colleges or universities to obtain B.S., M.S., or Ph.D. degrees in relevant scientific disciplines.

Please refer to www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

Advanced degrees (M.S., Ph.D.) are typically required for these positions. While **Chemistry** and **Biology** degrees provide a solid foundation, the undergraduate disciplines listed provide more targeted preparation:

- Agricultural Science
- Biochemistry
- Bioprocessing Science
- Biotechnology
- Food Science
- Genetics
- Microbiology
- Molecular Biology
- Pharmaceutical (or Biopharmaceutical) Science

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Chemist*
- Microbiologist*
- Biochemist*
- Natural Science Manager*
- Research and Development Scientist
- Research Associate
- Process Development Scientist
- Research Professor
- Environmental Scientist
- Forensic Scientist

Spotlight on Laboratory Technicians

ON THE JOB

Work Environment

Laboratory technicians can find employment with many different types of employers, from small testing laboratories to large manufacturers, government laboratories, and research universities. No matter who they work for, most laboratory associates spend most of their work day in the laboratory. They usually come to work in casual clothes. They wear lab coats supplied by their employers, as well as safety glasses and gloves, while working in the laboratory. Many laboratory technicians work normal business hours, while others may work different shifts to ensure that lab operations continue around the clock.

Knowledge and skill in chemistry, biochemistry, and microbiology have the widest applicability in these jobs. Technical writing skills are also a must, since technicians must often write reports and standard operating procedures. Much equipment is automated, so computer skills are also needed.

Salary and Advancement*

In North Carolina, average salaries for laboratory technicians are usually around $41,000. Starting salaries for an entry-level laboratory technician typically run about $30,000. More experienced laboratory technicians can earn $47,000 or more a year. As these figures do not reflect specific educational levels or types of companies, actual salaries may be higher or lower. Laboratory technicians with a B.S. degree may earn more than those with an associate's degree.

The salary figures above identify a range for positions similar to those outlined for laboratory technicians in this publication. Earning potential becomes greater as an individual's career progresses. Laboratory technicians can find rewarding careers in both technical and managerial roles within a laboratory, as well as pursue opportunities outside of a lab, through work experience or additional education.

** Salary ranges compiled from North Carolina data obtained from the U.S. Department of Labor's Bureau of Labor Statistics.*

"When I got out of high school, I just needed to get a good job as soon as possible. I decided to be a lab tech because I did well in chemistry. Now I'm beginning to see that I could have a real career here, not just a job, so I'm studying to get a B.S. degree to qualify for a position in the product development laboratory." — **David**

A Laboratory Technician at Work

David is a quality control associate at a company that uses biotechnology to manufacture chemicals used in food processing. He joined the company six years ago, after getting an associate's degree in laboratory technology at a nearby community college.

David spends his day in the laboratory, where he and two other technicians test samples of the company's products to make sure each batch meets specifications before it is shipped to customers. David is careful to follow the company's written procedures when conducting these tests. He knows that his company depends on him to ensure that they deliver only high quality products.

Just the other day, he got strange test results from an automated chromatography system. After consulting with his supervisor, he found that someone had re-programmed the system for a different test and didn't record the change. Because of his ability to solve problems, David has been given greater responsibility and is now experimenting with new testing methods for a new product. He was happy to find a position that pays well and has good benefits for his family. While the work requires discipline and attention, he enjoys the friendly atmosphere and the encouragement he gets to continue learning new things.

Working in a laminar flow hood to prevent contamination, a laboratory associate at Biogen Idec's North Carolina manufacturing facility inoculates a cell culture.

A laboratory associate at Diosynth Biotechnology runs analytical equipment to test the purity of a newly manufactured biopharmaceutical.

CAREER MAP: LABORATORY TECHNICIAN

Skilled laboratory technicians are valuable and responsible employees who have many job options. Scientists in many industry sectors trust laboratory technicians to conduct their research studies and rely on the data collected to make important decisions. Laboratory technicians spend most of their time working with complex instrumentation and laboratory equipment conducting experiments that may monitor product quality, identify a better way of making a product, research a new product, or even solve a criminal case. If you enjoy doing practical, hands-on science, this could be a good career choice for you.

Secondary Career Development Schedule

All students are encouraged to take any available biotechnology, higher-level mathematics, and higher-level science courses, beginning in middle school. In addition, coursework in business, computers, and communication are valuable in developing necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines. Science course sequences may vary by school.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Higher-Level Math *(Algebra II prerequisite)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principles of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Second Language	Second Language	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science *or* Mathematics Elective	Advanced Science *or* Mathematics Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for laboratory technicians: **Agriculture**: Biotechnology and Agriscience Research I & II; Horticulture I & II; **Food Science**: Foods II–Foods Technology; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Biotechnical Engineering specialty course); **Health Sciences**: Biomedical Technology, Medical Sciences I & II. In addition, Advanced Studies courses with a biotechnology focus are encouraged in all of these areas.

North Carolina Postsecondary Options

Community College Programs

Associate in Applied Science (A.A.S.) programs include:

- Agricultural Biotechnology
- Biotechnology
- Chemical Technology
- Environmental Science Technology
- Industrial Pharmaceutical Technology
- Laboratory Technology
- Nanotechnology
- Bioprocess Technology
- Chemical Process Technology
- Medical Laboratory Technology

Please refer to www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

While **Chemistry** and **Biology** degrees provide a solid foundation, the undergraduate disciplines such as those listed provide more targeted preparation:

- Agricultural Science
- Biochemistry
- Bioprocessing Science
- Biotechnology
- Food Science
- Genetics
- Microbiology
- Molecular Biology
- Pharmaceutical (or Biopharmaceutical) Science

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Laboratory Technician
- Research Assistant
- Research Associate
- Quality Control Chemist
- Quality Control Microbiologist
- Environmental Technician
- Forensic Technician
- Clinical Laboratory Technician*
- Chemical Technician*
- Biological Technician*

Spotlight on Engineers

ON THE JOB

Work Environment

Engineers may work in an industrial, government, or academic environment. If they work in industry, they will usually work normal business hours. If they work for a company with a 24/7 manufacturing operation, they may also be on call after hours, in case they are needed to troubleshoot problems. Engineers are often on the go, from their office, to the manufacturing floor or testing laboratory, to construction sites or other field locations. Depending on their schedule for the day, they may wear a business suit, more casual street clothes, or work clothes and a hard hat.

Engineers often rely on sophisticated computer software to help them visualize and design manufacturing equipment and facilities. If you are interested in becoming an engineer, take as many computer courses as you can, especially those that give you an opportunity to learn graphics-oriented software.

Salary and Advancement*

In North Carolina, average salaries for engineers are usually around $65,000. Starting salaries for an entry-level engineer typically run about $46,000. More experienced engineers can earn $73,000 or significantly more, depending on how much education and experience they have. As these figures do not represent specific educational levels or types of companies, actual salaries may be higher or lower.

The salary figures above identify a range for positions similar to those outlined for engineers in this publication. Earning potential becomes greater as an individual's career progresses. Engineers also move out of engineering into other career areas such as process development, quality assurance and validation, project management, or consulting. Many high-level managers in biotechnology or pharmaceutical companies have an engineering background.

**Salary ranges compiled from North Carolina data obtained from the U.S. Department of Labor's Bureau of Labor Statistics.*

"When I was in college, biotechnology still seemed like science fiction. Soon I realized it was becoming a reality, so I went back to school for my master's degree. It's exciting to be part of a technological revolution. I like consulting because each project is different. Every time a new facility goes on line, I feel I've really accomplished something." – **Nicole**

Engineers also need skills in management and communications.

An Engineer at Work

Nicole is an engineer with a small consulting group that helps biotechnology companies design and build new manufacturing facilities. She began her career with a B.S. in chemistry.

Nicole is very experienced with biotechnology manufacturing, or bioprocessing. Before joining her partners in the consulting group, she worked for two agricultural companies and a chemical company that used bioprocessing, and then went back to school to earn an M.S. in biochemical engineering. Nicole's experience is highly valued by her clients, who are sometimes new to biotechnology manufacturing. Some clients are young companies that want to manufacture their first product. Others are established companies that want to upgrade their current facilities.

Nicole spends about half her time in her office, designing plants with towering steel tanks and miles of piping. The rest of her time is spent meeting with clients or with suppliers, or on construction sites that are located around the world. She works with a variety of people, including top managers, construction foremen, and scientists. She has found that short courses in communication skills, negotiation, and project management have been as valuable to her as any of her engineering courses.

CAREER MAP: ENGINEER

Engineers with an understanding of life science are central to the field of biotechnology. They may choose a career in industry, government, or academia. Process engineers design, supervise, and troubleshoot new manufacturing processes. They may also monitor manufacturing processes and work with technicians to ensure products are being manufactured properly. Engineers can design new production plants and oversee them. Engineers in industry may work with regulatory agencies, customers, or investors. Engineers in universities research new technologies for manufacturing. If you are good with electronics and machines, or like figuring out how to make things work and how to build them, you would probably like engineering.

Secondary Career Development Schedule

Science course sequences may vary by school. All students are encouraged to take any available higher-level mathematics and science courses, beginning in middle school. Courses in business, computers, and communication are valuable to develop necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Higher-Level Math *(Algebra II prerequisite)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principles of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Second Language	Second Language	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science *or* Mathematics Elective	Advanced Science *or* Mathematics Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for engineers: **Agriculture**: Biotechnology and Agriscience Research I & II; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Biotechnical Engineering specialty course), Electronics I & II, and, in addition, Advanced Studies courses with a biotechnology focus are encouraged in all of these areas.

North Carolina Postsecondary Options

Community College Programs

Students completing Associate of Science (A.S.) degree programs in pre-engineering can continue their education at four-year colleges or universities to obtain B.S. or advanced degrees in engineering.

Please refer to www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

B.S. degree in engineering is required. Advanced degrees (M.S., Ph.D.) are required for some positions. Specific fields include:

- Biological and Agricultural Engineering
- Biochemical and Bioprocess Engineering
- Biomedical Engineering
- Bioprocessing Science
- Chemical Engineering
- Electrical Engineering
- Environmental Engineering
- Food Science
- Industrial Engineering
- Materials Science
- Mechanical Engineering

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Process Engineer
- Production Engineer
- Facility Engineer
- Agricultural Engineer
- Environmental Engineer
- Chemical Engineer*
- Industrial Engineer*
- Mechanical Engineer*
- Consulting Engineer

Spotlight on Process Technicians

ON THE JOB

Work Environment

Process technicians are involved in every step in the process of manufacturing a biotechnology product and work in many different environments. A process technician may:

- Operate, monitor, and control biotechnology manufacturing equipment or equipment that packages and labels a finished product
- Clean and sterilize production equipment and glassware, mix solutions, and prepare media
- Mix active drug ingredients with other agents to make finished drug tablets, capsules, liquids, syrups, or ointments.

The work environment of process technicians depends largely on what kind of process their employer uses to make its products. The story, "A Process Technician at Work," on this page presents an example of a technician working in a large-scale industrial products plant. Pharmaceutical products—especially those that must be sterile—often are made in controlled environments, or clean rooms. Process technicians wear sterile jump suits and accessories that cover them from head to toe in order to protect both themselves and the product.

While equipment and environments may differ, all process technician jobs require attention to detail, some mechanical ability, and a high degree of responsibility.

Salary and Advancement*

In North Carolina, average salaries for process technicians are usually around $41,000. Starting salaries for an entry-level process technician typically run about $30,000. More experienced process technicians can earn $46,000 or significantly more, depending on how much education and experience they have. As these figures do not reflect specific educational levels or types of companies, actual salaries may be higher or lower.

The salary figures above identify a range for positions similar to those outlined for process technicians in this publication. Earning potential becomes greater as an individual's career progresses. With experience, process technicians can advance to lead technician and shift supervisor positions. They can also transfer to other functional areas within a company such as process development or quality.

**Salary ranges compiled from North Carolina data obtained from the U.S. Department of Labor's Bureau of Labor Statistics.*

"When I first got here, I was pretty intimidated by the equipment and all the pipes that seemed to go everywhere. But the company has in-house training, and you learn, one part at a time. After a while I felt very at home here. I liked figuring out how things work." – **Shawn**

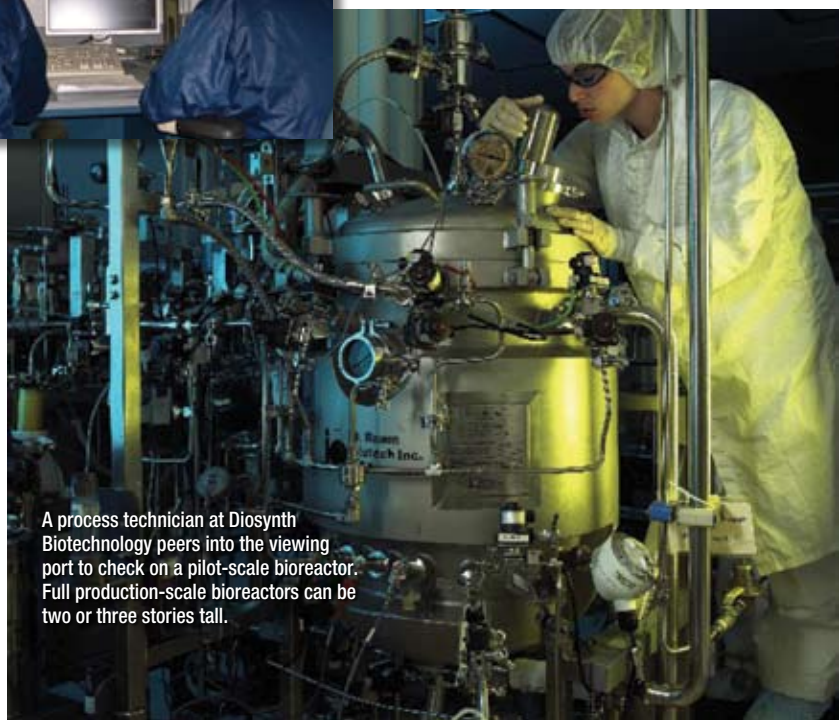
A Process Technician at Work

Shawn is a production team leader at a large-scale bioprocessing facility that grows microorganisms to produce a variety of organic compounds used in food processing and other industries. Shawn got his job based on his prior employment in textiles and a BioWork Certificate from a local community college. He gets out of his truck at 6:45 a.m. ready to start the workday. He is wearing jeans and safety work boots, and carries his hard hat and safety glasses. He first goes to the control room where the team on the previous shift is gathering to check out. It is important for Shawn to be on time so he can get a status report before they leave. This plant makes 15 different products and each one requires a different procedure. Shawn has to know what is happening and what he has to do to keep each batch running on schedule.

This kind of responsibility appeals to Shawn. He is independent and resourceful, and appreciates the trust his supervisor has in him. After four years on the job, he has learned all the different processes and equipment and enjoys troubleshooting. Shawn also likes working with his team. They sometimes get together after hours with their families.

He likes the active part of his job. The plant is spread out over several acres, so he often rides a bike between production areas, and likes the view from the catwalks near the tops of the three-story-tall fermentation tanks.

Process technicians at Talecris Biotherapeutics use a computer to monitor a manufacturing process. Process control software enables them to check critical conditions in tanks, and make necessary adjustments.



A process technician at Diosynth Biotechnology peers into the viewing port to check on a pilot-scale bioreactor. Full production-scale bioreactors can be two or three stories tall.

CAREER MAP: PROCESS TECHNICIAN

Process technicians must be highly skilled and dedicated workers. Their employers often entrust them with batches of product worth millions of dollars. They are responsible for the production of each batch and for helping to ensure its quality by taking samples for testing. If they identify problems, they help resolve them. Qualified process technicians are integral to the success of many biotechnology employers. It can take several years to train someone on all phases of a complex manufacturing process, so employers are highly motivated to retain their experienced process technicians with competitive salaries, excellent benefits, and opportunities for advancement. If you like technical work and get satisfaction from making things, you would probably make a good process technician.

Secondary Career Development Schedule

Science course sequences may vary by school. All students are encouraged to take any available higher-level mathematics and science courses, beginning in middle school. Courses in business, computers, and communication are valuable to develop necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Elective *(Advanced Math Recommended)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principles of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Elective *(Second Language Recommended)*	Elective *(Second Language Recommended)*	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science Elective	Advanced Science Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for process technicians: **Agriculture**: Biotechnology and Agriscience Research I & II; **Food Science**: Foods II–Foods Technology; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Computer Integrated Manufacturing or Biotechnical Engineering specialty courses), Electronics I & II; **Health Sciences**: Biomedical Technology, Medical Sciences I & II. In addition, Advanced Studies courses with a biotechnology focus are encouraged in all of these areas.

North Carolina Postsecondary Options

Community College Programs

Associate in Applied Science (A.A.S.) programs include:

- BioWork (Certificate)
- Biotechnology (A.A.S. or Certificate)
- Industrial Pharmaceutical Technology (A.A.S.)
- Bioprocess Technology (A.A.S.)
- Chemical Process Technology (A.A.S.)

Please refer to www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

While some process technician jobs are filled by individuals with a B.S. degree, it is not necessary to obtain a four-year or advanced degree to secure employment as a process technician.

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Bioprocess Manufacturing Technician
- Aseptic Manufacturing Technician
- Manufacturing Preparation Technician
- Formulation and Fill Technician
- Inspection Technician
- Packaging Technician
- Process Technician
- Manufacturing Associate
- Chemical Equipment Operator*
- Chemical Plant and System Operator*

Spotlight on Maintenance and Instrumentation Technicians

ON THE JOB

Work Environment

Maintenance and instrumentation technicians can find employment with many different types of employers, including manufacturers, large government laboratories, and research universities. No matter who they work for, they usually spend most of their day installing, monitoring, maintaining, troubleshooting, and repairing utilities and instrumentation. If they work on mechanical equipment, they often wear coveralls to protect their clothing from grease and oils. If they work at a facility that makes sterile products, they may sometimes have to put on special clothing for clean rooms. Many maintenance and instrumentation technicians work normal business hours, but those who work for a manufacturer with a 24/7 production line may work on a shift schedule.

Maintenance and instrumentation technicians don't just keep equipment running smoothly. They also document its performance status on an ongoing basis. Engineers rely on these records to answer critical questions whenever they need to troubleshoot problems with the manufacturing process. These records are also an important part of the documentation that auditors review to see if the company is complying with its operating procedures and with regulatory requirements. Maintenance and instrumentation technicians need good basic writing skills to maintain clear and complete records.

Salary and Advancement*

In North Carolina, average salaries for maintenance and instrumentation technicians are usually around $44,000. Starting salaries for an entry-level maintenance and instrumentation technician typically run about $32,000. More experienced maintenance and instrumentation technicians can earn $51,000 or significantly more, depending on how much education and experience they have. As these figures do not reflect specific educational levels or types of companies, actual salaries may be higher or lower.

The salary figures above represent a range for positions similar to those outlined for maintenance and instrumentation technicians in this publication. Earning potential becomes greater as an individual's career progresses. Experienced maintenance and instrumentation technicians with appropriate certifications can advance into supervisory positions. Over the long run, an associate's degree will usually bring better opportunities for advancement and more career flexibility.

**Salary ranges compiled from North Carolina data obtained from the U.S. Department of Labor's Bureau of Labor Statistics.*

A maintenance technician at Diosynth Biotechnology inspects the piping that supplies clean water to equipment used in the manufacturing process.

"I've always loved tinkering with stuff. When I got out of high school, I worked with my father and uncle in their heating and cooling business for several years. Then I heard that biotechnology companies were looking for people with my technical education and skills. Now I'm earning good money and working with some very cutting-edge technology." – **Andre**

An instrumentation technician at Talecris Biotherapeutics inspects a group of control valves that govern the fluid flow through pipes carrying product manufactured at the Clayton, North Carolina, facility.

A Maintenance and Instrumentation Technician at Work

Andre is a maintenance and instrumentation technician with a company that uses biotechnology in its manufacturing process. He joined the company six years ago after getting an Associate in Applied Science degree (A.A.S.) in Industrial Systems Technology from a local community college.

Andre spends a lot of time on the manufacturing floor, making sure that the manufacturing equipment and instrumentation are working properly. He spends very little time at his desk. He usually works on the equipment and instruments by himself, but he sometimes visits with the company's process technicians who are often on the manufacturing floor with him.

Andre is responsible for a wide variety of facility systems including heating, ventilation, and air conditioning (H.V.A.C.); water purification; and steam generation. In addition, he maintains a complex network of computer interfaces, valves, and pipes carrying both gases and liquids. Repair work orders for all of these systems and parts are communicated to Andre through a computer system for managing maintenance work. If he is late responding to a work order to fix a broken steam valve, he could potentially delay or jeopardize the entire manufacturing process.

CAREER MAP: MAINTENANCE AND INSTRUMENTATION TECHNICIAN

Maintenance and instrumentation technicians are valuable employees who seldom have difficulty finding employment. They are responsible for keeping the manufacturing facility in good running order; if the manufacturing line goes down, the company loses money. Maintenance and instrumentation technicians maintain the electrical, heating, ventilation, air conditioning, and water-purification systems. They also maintain the pumps, valves, piping, and other complex equipment used in the manufacturing process. If you enjoy tinkering with things, are good at troubleshooting and repairs, and take pride in your work, you would probably make a good maintenance and instrumentation technician.

Secondary Career Development Schedule

Science course sequences may vary by school. All students are encouraged to take any available higher-level mathematics and science courses, beginning in middle school. Courses in business, computers, and communication are valuable to develop necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Elective *(Advanced Math Recommended)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principles of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Elective *(Second Language Recommended)*	Elective *(Second Language Recommended)*	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science Elective	Advanced Science Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for maintenance and instrumentation technicians: **Agriculture**: Agricultural Mechanics I & II; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Computer Integrated Manufacturing or Biotechnical Engineering specialty courses), Electronics I & II; **Industrial**: Metals Manufacturing I & II.

North Carolina Postsecondary Options

Community College Programs

Associate in Applied Science (A.A.S.) and diploma programs include:

- Automation Engineering Technology
- Electrical Engineering Technology
- Electronics Engineering Technology
- Instrumentation
- Industrial Engineering Technology
- Manufacturing Engineering Technology
- Materials Science Technology
- Mechanical Engineering Technology
- Electronics Technology
- Facility Maintenance Technology
- Facility Maintenance Worker (Diploma)
- Industrial Systems Technology
- Industrial Management Technology
- Manufacturing Technology

Please refer to www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

It is not necessary to obtain a four-year or advanced degree to secure employment as a maintenance and instrumentation technician.

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Facilities Technician
- Maintenance Technician
- Mechanic
- Instrumentation Technician
- Refrigeration and HVAC Technician
- Electrical and Electronic Engineering Technician*
- Maintenance and Repair Worker*

Spotlight on Corporate Scientific Professionals

ON THE JOB

Work Environment

Most corporate scientific professionals are salaried employees who work normal business hours in corporate offices. They travel to business meetings and conferences, often meeting with people from outside of the company, and usually wear business attire.

Individuals who combine an education in science with an education in business, law, medicine, or communications will find a number of different careers open to them in biotechnology.

- **Science degree plus... BUSINESS**
  Career choices: Business development, sales and marketing, project management
- **Science degree plus... LAW**
  Career choices: Patent attorney, corporate counsel
- **Science degree plus... MEDICINE / NURSING**
  Career choices: Medical director, clinical research associate
- **Science degree plus... COMMUNICATIONS**
  Career choices: Science writer, technical writer, medical writer, public relations, customer service

The pharmaceutical industry also hires individuals with diverse backgrounds as regulatory professionals, who are responsible for ensuring that their company complies with complex regulations involving pharmaceutical manufacturing, environmental impact, and worker safety. Such experts also find employment in government.

Salary and Advancement

Corporate scientific professionals possess a tremendous breadth of expertise and experience and are very well compensated. They also have excellent opportunities for advancement. Their professional experience on the job and understanding of the scientific foundation of the business make them well suited for management positions. Because of the diversity of these positions and the varied education and experience that lead to them, salary figures are not easily available. Salaries can be expected to be equivalent to middle- or higher-level business managers or medical and legal professionals.

"I decided to go into marketing because I think it's creative and I like interacting with people. I started out in science, but I couldn't see spending the rest of my life in the lab. I never dreamed I'd get a job that let me travel to foreign countries!" — **Tamara**

A Corporate Scientific Professional at Work

Tamara is a marketing manager for an international company that produces diagnostic test kits for a wide range of illnesses. She joined the company four years ago, after getting a Bachelor of Science degree (B.S.) in Biochemistry and a Master of Business Administration degree (M.B.A.) with a concentration in marketing. Her employer was eager to hire her because she speaks Spanish fluently.

Tamara is responsible for a product line that is marketed in North, Central, and South America. She tracks demand for the product through market research, sales figures, and reports from the company's sales representatives. She is responsible for developing product advertising campaigns and for monitoring the competition. She also makes recommendations for product improvements to meet consumer demands. Her job takes her out of the country several times a year.

Tamara usually spends her day in the company's corporate offices, working at her desk or in meetings. She keeps in close contact with the company's sales representatives, who are her pipeline to the retailers that distribute her product line. She also works with advertising agencies selected by the company to develop advertising campaigns for its products.

Her background in science gives her a better understanding of the company's products, and helps her identify new applications and market niches, as well as talk to diverse audiences about the unique value of the products.

Corporate scientific professionals often combine science with "people skills."

CAREER MAP: CORPORATE SCIENTIFIC PROFESSIONAL

Corporate scientific professionals have many roles including clinical trials managers, regulatory experts, and patent attorneys, as well as marketing executives, technical writers or trainers, and customer service or sales representatives. They may like science and obtain B.S. degrees in scientific or engineering disciplines, but often discover, through education or work experience, that they enjoy working with people, management, and policy issues more than working in laboratories. As a result, they seek out career opportunities that will utilize this combined interest in science with another specialized area such as business, law, medicine, or communications. Biotechnology companies value such professionals because they combine specialized scientific knowledge with other expertise.

Secondary Career Development Schedule

Science course sequences may vary by school. All students are encouraged to take any available higher-level mathematics and science courses, beginning in middle school. Courses in business, computers, and communication are valuable to develop necessary career skills. Students pursuing a College Tech Prep course of study need four related Career-Technical Education (CTE) credits; ask your counselor for your school's guidelines.

Grade 9	Grade 10	Grade 11	Grade 12
English I	English II	English III	English IV
Algebra I *or* Integrated Math I	Geometry *or* Integrated Math II	Algebra II *or* Integrated Math III	Higher-Level Math *(Algebra II prerequisite)*
Earth/Environmental Science	Biology	Science Elective *(Chemistry Recommended)*	Science Elective *(Physics or Principles of Technology I & II Recommended)*
World History	Civics & Economics	U.S. History	Elective
Health/Physical Education	Second Language	Second Language	Elective *(Second Language Recommended)*
Elective	Elective	Advanced Science *or* Mathematics Elective	Advanced Science *or* Mathematics Elective
Elective	Elective	Elective	Elective
CTE Elective*	CTE Elective*	CTE Elective*	CTE Elective*

***CTE Electives**: Specific course offerings will depend upon local availability. The following electives either cover some aspects of biotechnology or build useful knowledge or skills for corporate scientific professionals: **Agriculture**: Biotechnology and Agriscience Research I & II; **Food Science**: Foods II–Foods Technology; **Engineering**: Scientific and Technical Visualization I & II, Project Lead the Way (Biotechnical Engineering specialty course); **Health Sciences**: Biomedical Technology, Medical Sciences I & II. In addition, Advanced Studies courses with a biotechnology focus are encouraged in all of these areas.

North Carolina Postsecondary Options

Community College Programs

Students completing Associate of Science (A.S.) degree programs in chemistry, biology, pre-engineering, or physics can continue their education at four-year colleges or universities to obtain B.S., M.S., or Ph.D. degrees in relevant scientific disciplines.

Clinical Trials Research Associate certificate and degree programs are a good option.

Visit www.ncbionetwork.org *or* www.nccommunitycolleges.edu *for specific course and program offerings in your area.*

Four-Year College and University Programs

B.S. degree in scientific or engineering discipline is usually required. While **Chemistry** and **Biology** degrees provide a solid foundation, the undergraduate disciplines listed provide more targeted preparation:

- Biochemistry
- Bioprocessing Science
- Biochemical and Bioprocess Engineering
- Biotechnology
- Chemical Engineering
- Genetics
- Microbiology
- Molecular Biology
- Pharmaceutical (or Biopharmaceutical) Science

Advanced degrees are required for some positions. Some potentially useful post-graduate and specialized degrees include:

- M.S. & Ph.D. (life/physical sciences and engineering)
- Medical Doctor (M.D.)
- Juris Doctor (J.D.)
- Master of Business Administration (M.B.A.)
- Professional Science Masters
- Technical Communication
- Journalism

Please refer to www.northcarolina.edu *for more information on specific program offerings.*

Sample Job Titles

Job titles indicated with an asterisk are included in the federal Standard Occupational Classification (S.O.C.) System and are used in many career information resources. Other common job titles in industry are also included.

- Project Manager
- Pharmaceutical Sales Representative
- Marking Specialist
- Patent Attorney
- Regulatory Affairs Specialist
- Clinical Research Associate
- Quality Assurance Associate
- Corporate Trainer
- Clinical Researcher
- Technical Writer*
- Sales Representative*
- Lawyer*