Careers for scientists—and others—in scientific research and development

by Nicholas Terrell

Creating supercomputers out of tiny nanotubes. Identifying how proteins regulate activity in plant cells. Developing next year's hottest cars. Workers in the scientific research and development services industry create today the technologies that will change the way people live and work in the future.

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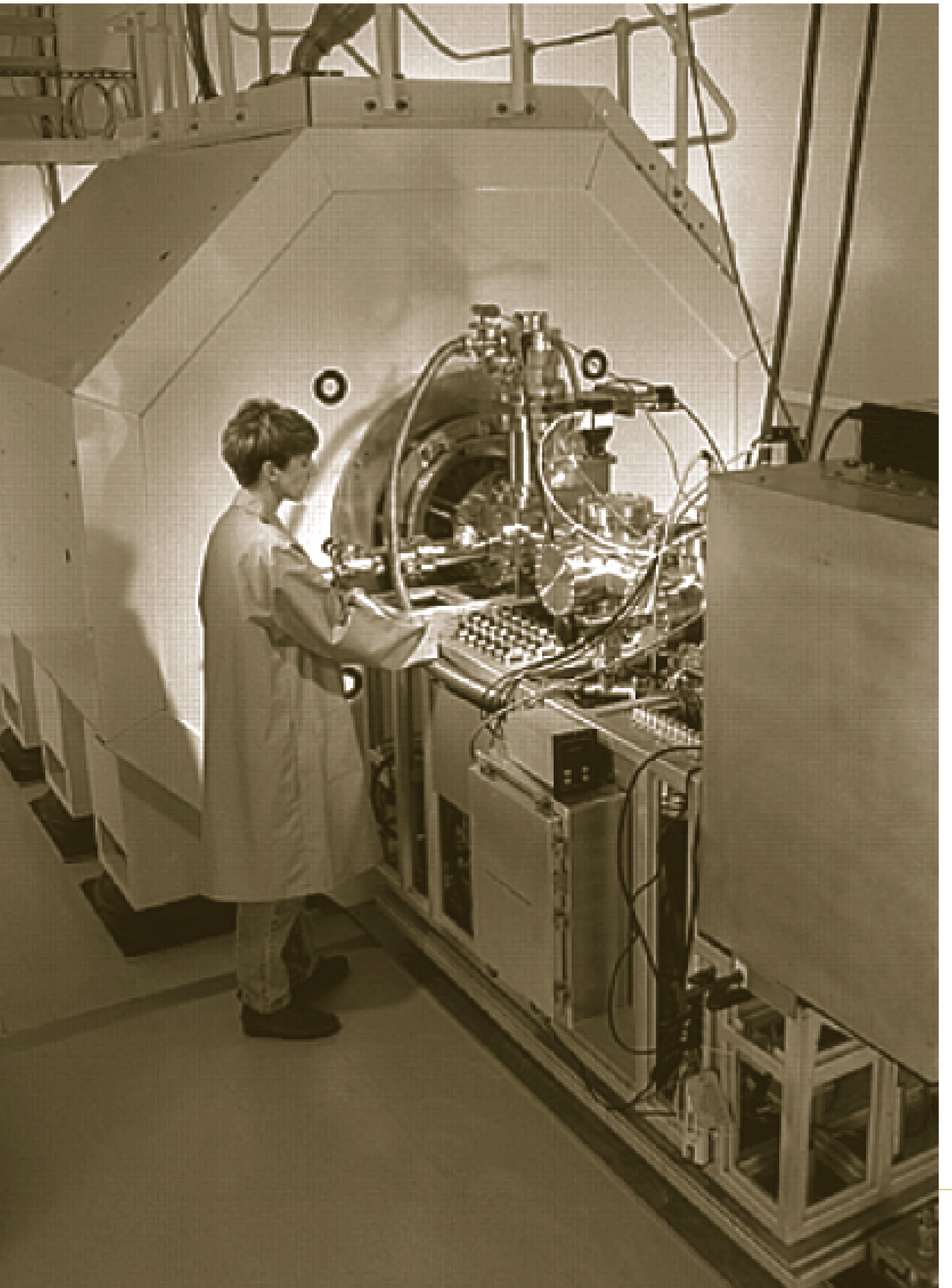
To gauge the importance of this industry, consider the attention it receives from the press, business associations, politicians, and the financial markets. Major discoveries are heralded in both the technical and popular media, and many studies monitor the pace of research and development. As the success of the Internet demonstrates, new technologies can quickly revolutionize business and leisure.

Companies often conduct their research and development (commonly referred to as "R&D") in separate laboratories and workshops. The people who work in these facilities are part of the scientific research and development services industry. Research and development occurring in establishments that mainly engage in other activities, such as manufacturing or educational services, are not counted as part of this industry.



Workers in the scientific research and development services industry include scientists and engineers, of course. But the industry also includes managers, accountants, people who interview test subjects, and many other workers in a range of occupations. All of these workers contribute to scientific breakthroughs and the development of new or improved products.

This article describes the scientific research and development services industry: its organization, occupations, benefits and drawbacks for workers, job outlook, training requirements, and advancement opportunities.

Constantly in flux: The nature of R&D

The scientific research and development services industry provided 549,950 jobs in 2004, according to the U.S. Bureau of Labor Statistics (BLS). Workers are employed nationwide, but six States—California, New York, Massachusetts, Illinois, New Jersey, and Michigan—together accounted for more than half of all research and development jobs. Much of the research

Some scientific research and development is performed in laboratories and workshops.

and development in the automotive field is conducted in Michigan.

Research and development includes three types of activities: Basic research, applied research, and development. In addition, the industry is divided into two distinct categories. One comprises physical, engineering, and life sciences; the other includes social sciences and humanities.

Types of R&D work

Nearly everything we use, from antibiotics to zoom lenses, is the result of basic research, applied research, and development.

Basic research expands scientific knowledge but is not applied directly to real-world situations. This sort of research typically involves a high level of theory and is very risky; many projects fail to produce conclusive results. Basic research includes, for example, studying the properties of antibodies to learn more about how they work. Because of the risk and the broad applicability of the results, most basic research is funded by State governments, the Federal Government, universities, and nonprofit organizations. Scientists involved in basic research typically work for these employers.

Applied research is the bridge between science and business. It is conducted to solve some general scientific problem but, instead of simply increasing knowledge, applied research aims for the more concrete goal of helping to eventually create a product. This research will not create a final product, but it might generate viable options. For example, applied research might lead to the discovery of antibodies that can be used to create better vaccines.

Development, according to the National Science Board, accounts for more than half of all research and development funding. Development is the stage in which researchers refine the technologies or processes of applied research into usable products. So, in the previous example, development would involve researchers seeking a way to create and mass produce a particular vaccine. Most development is done by private industry and is generally geared toward manufacturing.

Workers in this industry contribute to scientific breakthroughs and the development of new products.

Physical, engineering, and life sciences

According to BLS data, workers in the physical, engineering, and life sciences accounted for about 89 percent of employment in the scientific research and development services industry in 2004. Important areas of research and development in these sciences include the aerospace, automotive, biotechnology, chemical and materials science, electronics, nanotechnology, and pharmaceutical fields.

Aerospace. Research and development in aerospace involves the study and creation of aircraft, spacecraft, missiles, and component parts and systems. More than half of the research and development in aerospace is federally funded. The U.S. Department of Defense and the National Aeronautics and Space Administration (NASA) are the largest supporters of aerospace research and development, with defense-related programs accounting for most of the work.

Most civil aerospace research and development is devoted to making air transportation cheaper and safer. Other projects include upgrading passenger aircraft and designing private spacecraft to launch satellites or transport people into space.

Workers who handle potentially dangerous materials must follow safety procedures.

Automotive. Automotive research and development leads to new vehicles and systems that are more efficient, powerful, and reliable. Significant automotive research and development is directed toward integrating new technologies into complete vehicles. But there is also much research on improving individual components, such as light emitting diode (LED) headlights and fuel injectors.

As electronic technology has advanced, so have automotive designs. Incorporating computer systems both for monitoring performance and as separate features has added a new dimension to research and development in this field. With the demand for efficiency—vehicles that use less fuel to provide more power—a good deal of time and resources are devoted to the research and development of transmission systems and car bodies.

Biotechnology. One of the most active fields of research is biotechnology, which receives at least one-fourth of all funding in the scientific research and development services industry, according to the National Science Board. Workers in this field seek to use basic processes of cellular biology to improve medicines, consumer products, and industrial processes. Much of the work in biotechnology relates to basic and applied medical research.

Advances in biotechnology have led to new drugs and vaccines, disease-resistant crops, and novel methods of dealing with hazardous materials. A particularly vibrant branch of biotechnology is bioinfomatics, which involves the use of biological data, such as DNA.

Chemical and materials science. Research and development in chemical and materials science focuses on the design and creation of new molecules or materials that have useful properties. Researchers might develop new chemical structures that are stable or volatile, rigid or flexible, insulating or conducting.

Because chemical research and development is important to many technologies, it includes work on computer chip manufacturing processes, composite materials development, and reducing pollution through chemical treatment. It also is important in both biotechnology and nanotechnology research and development.

Electronics. Technologies that incorporate electronics research and development include computer hardware, telecommunications, consumer electronics, automated control systems, medical equipment, and electronic sensing. Research and development in this field produces advances that make electronic systems faster and more reliable, compact, useful, powerful, and accessible.

Developing new technologies and integrating existing systems with new functions account for much of the research and development in this field. Basic research in areas such as electromagnetics and photonics is also a significant part of the work.

Nanotechnology. Nanotechnology is the creation and study of new structures that are roughly the same size as individual atoms, about 1 one-millionth of a millimeter. At this size, materials behave differently and so can be used to build very small devices, such as quantum dots that act like artificial atoms or hydrophobic coatings for stain-repellent clothing.

With basic and applied research composing the bulk of work in this field, there are still relatively few applications of nanotechnology. The National Nanotechnology Initiative coordinates research funding from Federal agencies and aids in developing new technologies that result from this research.

Pharmaceutical. Pharmaceutical research and development involves the discovery of new drugs, antibiotics, and vaccines to treat or prevent a wide range of health problems. This field also has benefited from advances in biotechnology and nanotechnology, which have produced better models of biochemical processes and more efficient testing.

The time required to develop a new treatment is extensive, so most companies have several major programs running concurrently. This is sometimes referred to as the development "pipeline." Because many projects incorporate all aspects of research and development, the pharmaceutical field usually involves more basic research than do other established fields of research and development.

Social sciences and humanities

BLS data show that in 2004, 12 percent of employment in the scientific research and development services industry was in the social sciences and humanities. Important fields of research and development in these disciplines include economics, sociology, anthropology, and psychology. This area does not employ the variety of occupations that the physical, engineering, and life sciences do; social scientists typically work in fields directly related to their training.

Economic research typically involves monitoring and forecasting economic trends that relate to issues such as business cycles, competitiveness of markets, and international trade. Sociological research analyzes the institutions and patterns of social behavior in society, with the results used mainly by administrators to set policies. Anthropological research focuses on the influence of evolution and culture on human behavior.

The jobs of tomorrow—today

Not surprisingly, most people who do research and development are in the professional and related occupa-

In this industry, as in many, the tasks and hours at which workers must perform depend on the requirements of specific projects.

Employment and earnings for the most common occupations in scientific research and development services, May 2004

Occupation	Employment	Median annual earnings in scientific R&D services industry	Median annual earnings averaged across all industries
Executive secretaries and administrative assistants	19,070	$40,820	$34,970
Computer software engineers, systems software	18,030	91,390	79,740
Medical scientists, except epidemiologists	17,820	65,110	61,320
Biological technicians	14,870	36,520	33,210
General and operations managers	12,950	120,420	77,420
Chemists	11,550	62,460	56,060
Office clerks, general	11,360	27,730	22,770
Secretaries, except legal, medical, and executive	10,470	32,700	26,110
Mechanical engineers	10,440	74,570	66,320
Computer software engineers, applications	9,790	79,000	74,980
Electronics engineers, except computer	7,880	90,330	75,770
Engineering managers	7,730	116,980	97,630
Interviewers, except eligibility and loan	7,620	22,280	23,670
Industrial engineers	7,330	78,490	65,020
Natural sciences managers	7,160	106,530	88,660
Social science research assistants	6,790	32,820	34,360
Biochemists and biophysicists	6,710	73,900	68,950
Accountants and auditors	6,520	56,940	50,770
Electrical engineers	6,480	78,150	71,610
Sales representatives, wholesale and manufacturing, technical and scientific products	6,270	72,710	58,580

tions group. This includes scientists, engineers, computer specialists, and science technicians. Many others in the scientific research and development services industry come from the management, business, and financial operations group and the office and administrative support group. Few workers in this industry are in production, transportation, sales, or service occupations.

Professional and related occupations

Workers in professional and related occupations account for more than half of the employment in the scientific research and development services industry. About 47 percent of workers in the industry are in life and physical science occupations, engineering occupations, and computer and mathematical sciences occupations. With their research training and specialized expertise, scientists and engineers design, conduct, and analyze experiments and studies. Another 3 percent are in social sciences and related occupations.

Life, physical, and social scientists. These scientists form the core of research operations in the scientific research and development services industry. Biological scientists, medical scientists, and chemists and materials scientists are the most prevalent.

Biological scientists conduct research to understand biological systems, to develop new drugs, and to work with genetic material. Most of these scientists work for pharmaceutical or biotechnology companies; others work in Federal or academic laboratories.

Medical scientists research the causes of health problems and diseases, and they use this information to develop medical prevention and treatment. Their work is similar to that of biological scientists, but their emphasis is on disease prevention and treatment.

Chemists and materials scientists research the nature of chemical bonds and reactions and the properties of materials—and then develop new products and processes based on this knowledge. These scientists perform research that is used by an array of industries to develop new products. Along with physicists, some chemists and materials scientists research nanotechnology.

Engineers and computer specialists. These workers are usually involved in applied research or development.

Engineers design, produce, and evaluate solutions to problems, either by creating new products or by refining existing ones. They apply current research findings to develop efficient products or processes.

Engineering technicians assist engineers in preparing equipment for experiments, recording and calculating results, and building prototypes. Their work is similar to that of the engineers with whom they work but is more limited in scope.

Computer specialists—such as computer scientists, computer programmers, and computer software engineers—develop new computer technologies, programming languages, operating systems, and programs to increase computers' usefulness. Their work may involve integrating advances in computing theory into more efficient processing techniques.

Social scientists. Social scientist occupations include economists, market and survey researchers, sociologists, and anthropologists. These workers research human behavior and social interaction.

Science technicians. Sometimes called research assistants, science technicians help scientists in their research and typically specialize in an area of research. Their duties might include setting up and maintaining laboratory equipment, monitoring experiments, recording results, and interpreting collected data.

Management, business, and financial occupations

Another 20 percent of employment in the scientific research and development services industry is in management, business, and financial occupations. Engineering and natural science managers accounted for a larger portion of the employment in this industry than in other industries. These managers plan, coordinate, and direct the activities of engineers, natural scientists, technicians, and support personnel to conduct research and develop new products.

Natural science managers usually lead basic research, whereas engineering managers usually oversee development projects. Managers explain the technical aspects of projects to top executives. They also develop budgets and set incremental goals for research to meet business objectives. Engineering and natural science managers use their technical expertise and business acumen to bridge gaps between top management and researchers.

Office and administrative support occupations

Workers in office and administrative support occupations accounted for 15 percent of the employment in the scientific research and development services industry, primarily handling administrative and clerical tasks. For the most part, the administrative tasks of workers in this industry are similar to the administrative tasks of workers in other industries, but a few have a more scientific twist.

Interviewers, for example, are prevalent in research and development in the social sciences and humanities, accounting for 8 percent of the administrative support workers in this industry. They may be involved in soliciting and verifying information, either in person or by telephone, from individuals or groups who are the subjects of sociological, psychological, or market survey research. In the life sciences, interviewers might collect information about people participating in drug trials and other medical research.

Other occupations

Because workers in the scientific research and development services industry deal mainly with information and design, there is relatively little employment in production, transportation, sales, and service occupations. These occupational groups represent less than one-tenth of the industry's employment.

R&D work: What it's like and what it pays

Working in research and development can be exciting, but it requires patience, attention to detail, and, often, following safety procedures. The experiments and tests that workers perform can take time and sometimes involve working with hazardous materials.

The specific working conditions and earnings in the industry vary by occupation. A scientist, for example, might spend time working in a laboratory or performing calculations, whereas an interviewer who gathers information might spend more time on the telephone. The scientist will likely earn more, in part because of the increased educational requirements of the occupation.

Working conditions

Jobs in the scientific research and development services industry rarely pose significant risk of injury or illness to the workers who hold them. But comprehensive safety procedures are strictly enforced, particularly for those working in fields that require handling potentially dangerous materials.

The hours and locations for performing work tasks depend on the requirements of each project. For example, experiments may run at odd hours, require constant observation, or depend on external conditions, such as the weather. Research and development jobs demand a good deal of patience. Waiting for tests to run or for component parts to be built for a prototype can be both exhilarating and frustratingly slow.

In 2004, workers in the scientific research and development services industry averaged nearly 42 hours per week, roughly the same as the 41 hours that workers in the professional and technical services industry spent on the job each week. Workers in both industries put in somewhat more than the 39 hours per week averaged by workers in all industries.

Most people in this industry work in offices, laboratories, or workshops. In some fields, though, research or testing or both must be done in harsh environments to ensure the usefulness of a final product. Other research, particularly biomedical research, is done in hospitals. Research design, which attempts to find the best way to design a product, typically is done in offices. Workers focusing on product development may spend much of their time building prototypes in workshops or laboratories.

Earnings

In 2004, nonsupervisory workers in the scientific research and development services industry earned $66,610 per year at the median, which means that half of the workers earned more than this amount and half earned less. These median annual earnings were substantially higher than the national average of $37,020 for workers in all industries. And median earnings were higher for workers doing research and development in the physical, engineering, and life sciences ($68,420) than for those working in the social sciences and humanities ($52,760).

Earnings also vary by occupation. In 2004, workers in management and professional occupations had the highest annual earnings, $114,580, and those in personal care and service occupations had the lowest, $22,700. As the table on page 36 shows, most workers in the scientific research and development services industry earned more than did their counterparts in other industries.

In this industry, as in most, occupations that have higher earnings typically require higher levels of education and experience.

What the future holds

Even though the demand for new research and development is expected to continue growing across all major fields, projected job growth in the scientific research and development services industry varies by occupation. Job growth may be dampened, however, because of increased efficiency and the rising costs of equipment.

Although relatively slow growth is expected in nearly all of the major occupational groups within the industry, the most new jobs are projected to be in professional and related occupations. Scientists and engineers, particularly those in the life and medical sciences, are expected to have the largest job growth. Biotechnology and nanotechnology are expected to continue growing, driven by increased demand for new drugs and procedures.

Employment of computer scientists, particularly those with some biological science background working in bioinfomatics, also is projected to grow as information technology continues to be an integral part of research and development.

Slower job growth is expected in all but the management and professional occupations, however. Office and administrative support occupations, for example, are projected to have an overall decline in employment as technology enables greater efficiency in general office functions.

Most research and development programs have lengthy project cycles that continue during economic downturns. But funding of research and development, particularly by private industry, is closely scrutinized during these periods. Because the Federal Government provides about one-fourth of all research and development funding, shifts in policy also could affect employment opportunities.

Opportunities are expected to be best for scientists and engineers who have a doctoral degree because these degrees are tied to research. Scientists and engineers engaged in research and development must also be creative if they are to fulfill their role as innovators of new research and designs. Experienced scientists and engineers should stay up to date and be able to adapt to changes in technologies that may shift interest—and employment—from one area of research to another.

Career development

The scientific research and development services industry relies on workers who have extensive postsecondary education. In 2004, workers who have a bachelor's or higher degree held 68 percent of jobs in the industry, compared with 30 percent in all industries. The difference was particularly great for those who have a graduate degree, a group that accounted for 36 percent of workers in this industry compared with 10 percent of workers in all industries.

People who have a high school diploma, some college, or an associate degree may enter the scientific research and development services industry as science or engineering technicians. Some bachelor's degree holders also start their careers in the industry as technicians before advancing into research or pursuing additional education.

Technicians usually work under the direct supervision of a scientist, engineer, or senior technician and gradually gain more independence. Continuing on-the-job training is important for using the newest equipment and methods. Some technicians advance to become supervisors responsible for a laboratory or workshop.

For other science and engineering occupations, a bachelor's degree is generally the minimum level of education; for senior scientists and engineers, a master's degree or doctorate in philosophy (Ph.D.) is typically necessary. Some fields, particularly in the physical and life sciences, require a Ph.D. even for entry-level research positions. For many types of work in development outside the life sciences, a bachelor's degree is sufficient—but a master's degree is more common, especially among engineers.

In the life sciences, employers increasingly prefer to hire scientists who have a Ph.D. and have completed a period of academic research, known as a "postdoc," immediately after obtaining a degree. Postdocs may last several years, during which researchers receive low salaries and may have little independence. But for many, the opportunity to be on the cutting edge of science and technology is worth the extra work.

Continuing education and on-the-job training help workers to keep current in their field.

Workers who have a Ph.D. typically begin in the industry as researchers, conducting and designing research projects in their field of expertise. As scientists and engineers gain expertise in a field of research and development, they must choose between advancing to more senior research positions or becoming managers. Those in technical positions typically undertake more creative work in designing research or developing new technologies at a higher level. Successful senior researchers need a thorough understanding of theory and continually ask, "Why does this happen?" and "How can I improve it?"

Those in science and engineering management usually coordinate work in several disciplines. As their careers progress, they manage larger projects and ensure that the work aligns with the goals of an organization. Nearly all managers are responsible for some aspect of funding and for meeting deadlines. In addition to technical knowledge, successful science and engineering managers need to have good people skills.

The education and experience needed by other workers in the industry varies widely. For example, some interviewers may need specialized training in sociology or medicine; other interviewers may need good verbal communication and people skills. Typically, the requirements for workers in nontechnical occupations in this industry are similar to those for workers in other industries—although an interest in science or engineering never hurts.

Continual training is necessary for workers to keep pace with developments in their fields. This may include receiving on-the-job training or formal training or attending conferences and meetings of professional societies. Researchers keep current by attending conferences, reading specialized journals, and conferring with colleagues in industry and academia. Workers who fail to remain current in their field and related disciplines may face unfavorable prospects if interest in their specific area of expertise declines.

Because of the high costs of equipment and the benefits of collaboration, self-employment in scientific research and development services is not common. However, opportunities to start small companies exist, especially in rapidly growing fields that are more likely to attract investment capital. Self-employed workers in this industry typically have advanced degrees and have worked in academia or other research facilities. Such workers form companies to develop commercial products that result from prior basic or applied research.

Researching careers in R&D

To learn more about the scientific research and development services industry, visit a library or career counseling office. Look for information about the industry and about occupations that are in the industry. Examples of these occupations include biological scientists, economists, engineering and natural science managers, engineering technicians, and market and survey researchers.

These and hundreds of other occupations are described in detail in the *Occupational Outlook Handbook*. It discusses the nature of the work, working conditions, job outlook, earnings, training requirements, and more for each of the occupations profiled. The *Handbook* is available in many libraries and career counseling offices and also is accessible online at **www.bls.gov/oco**.

For more information about careers in aerospace research and development, contact:

American Institute of Aeronautics and Astronautics
1801 Alexander Bell Dr., Suite 500
Reston, VA 20191
Toll-free: 1 (800) 639-AIAA (639-2422)
(703) 264-7500
www.aiaa.org

Aerospace Industries Association
1000 Wilson Blvd., Suite 1700
Arlington, VA 22209
(703) 358-1000
www.aia-aerospace.org

For more information about careers in automotive research and development, contact:

Society of Automotive Engineers International
400 Commonwealth Dr.
Warrendale, PA 15096
Toll-free: 1 (877) 606-7323 (United States and Canada only)
(724) 776-4970
www.sae.org

For more information about careers in biotechnology research and development, contact:

Biotechnology Institute
1840 Wilson Blvd., Suite 202
Arlington, VA 22201
(703) 248-8681
www.biotechinstitute.org

Biotechnology Industry Organization
1225 Eye St. NW., Suite 400
Washington, DC 20005
(202) 962-9200
www.bio.org

For more information about careers in chemical and materials science research and development, contact:

American Chemical Society
1155 16th St. NW.
Washington, DC 20036
Toll-free: 1 (800) 227-5558 (United States only)
(202) 872-4600
www.chemistry.org

For more information about careers in electronics research and development, contact:

Institute of Electrical and Electronics Engineers USA
1828 L St. NW., Suite 1202
Washington, DC 20036
(202) 785-0017
www.ieeeusa.org

For more information about careers in nanotechnology research and development, contact:

National Nanotechnology Coordination Office
4201 Wilson Blvd.
Stafford II, Room 405
Arlington, VA 22230
www.nano.gov

For more information about careers in pharmaceutical research and development, contact:

Pharmaceutical Research and Manufacturers of America
1100 15th St. NW.
Washington, DC 20005
(202) 835-3400
www.phrma.org

Another good way to learn about industries and occupations is to talk directly with workers about their jobs. A career counselor might be able to help you arrange an informational interview, job shadowing opportunity, or internship with someone who works in a field that interests you.