Sloan Career Cornerstone Center

Biology Overview

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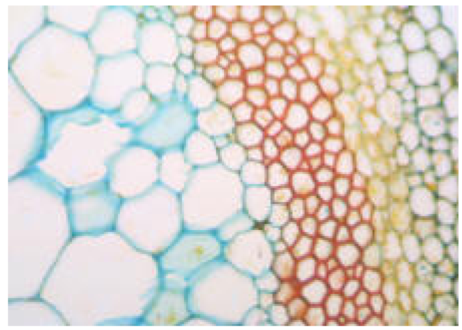
The Field



Biologists study living organisms: how they grow, reproduce, and interact among themselves and with their environment. Specialization in a particular aspect of biology is common (for example, neuroscience, which includes study of the brain, sensory perception, and nerve cell signaling).

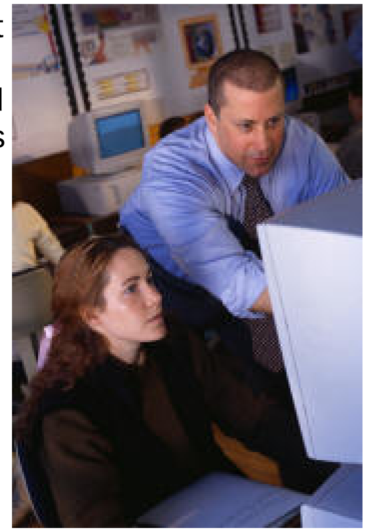
Regardless of the area of specialization, in modern biology full understanding of a process requires integrating studies at many levels of organization: populations, individual organisms, organ systems, cells, and molecules.

Biologists carry out research in universities, government laboratories, and industry. The research may be "basic," exploring a fundamental question to further our understanding of life processes. Such research may be in the laboratory or "in the field." Research may also be "applied," seeking to develop a new or better drug or biological pesticide, a new vaccine, or a way to conserve an endangered species, for example. Biologists in universities teach in addition to conducting research. These biologists must seek grant support for their research, from government or foundations.

Preparation

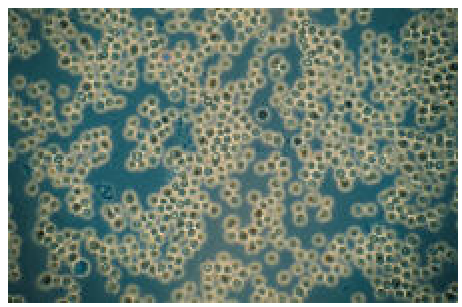
Careers are available in Biology at all preparation levels (bachelor’s, master’s, and doctoral degree), but the nature of the jobs change with additional preparation. A Ph.D. biologist usually conducts independent research, at least initially, but may move on to administrative/management positions. Preparation for such biologists usually includes not only doctoral studies, but also a period of more specialized training as a postdoctoral researcher.

A master’s degree biologist may conduct research as well, but most likely is not as independent as a Ph.D. In addition, careers are open as a high school teacher, museum educator, senior laboratory technician, or laboratory manager, for example. Teaching usually requires additional education courses for licensure. With a bachelor's degree, a biologist may be a teacher/educator, a laboratory technician, or be involved in technical sales or service. Many with a bachelor's degree in biology go on to medical, dental, veterinary, or other health professions schools. Policy or regulatory positions are open at all education levels, but as for research, the degree of independent decision-making increases with level of education.



Undergraduate coursework includes a broad range of sciences, not just biology. Chemistry, mathematics, and physics courses are required for a biology major and may be prerequisites for advanced biology courses. Computer skills are very important as well, but this may be self-taught.

For some fields (e.g., ecology, marine biology) geoscience courses may be a useful adjunct. Some colleges and universities have one biology department that offers a wide array of courses for students to choose among; other schools have two or more biology-related departments, each addressing a different area of specialization within biology (see the list below for names of specialized biology departments). Many biology courses involve not only classroom lectures but also laboratory and/or field work. Usually broad preparation is important for an undergraduate and detailed specialization occurs in graduate school.



Biologists should be able to work independently or as part of a team and be able to communicate clearly and concisely, both orally and in writing. Those in private industry, especially those who aspire to management or administrative positions, should possess strong business and communication skills and be familiar with regulatory issues and marketing and management techniques. (Sometimes this involves coursework, but may also be on-the-job training.) Those doing field research in remote areas must have physical stamina. Biologists also must have patience and self-discipline to conduct long and detailed research projects.

According to Peterson's, degrees in the broad field of Biological Sciences may include any of the following specialties.

- anatomy
- animal behavior and ethology
- animal genetics
- animal physiology
- aquatic biology/limnology
- biochemistry
- biochemistry, biophysics and molecular biology related
- biochemistry/biophysics and molecular biology
- bioinformatics
- biological and biomedical sciences related
- biological specializations related
- biology/biological sciences
- biomathematics and bioinformatics related
- biomedical sciences
- biometry/biometrics
- biophysics
- biostatistics
- biotechnology
- biotechnology research
- botany/plant biology
- botany/plant biology related
- cell and molecular biology
- cell biology and anatomical sciences related
- cell biology and histology
- conservation biology
- ecology
- ecology, evolution, systematics and population biology related
- entomology
- environmental biology
- environmental toxicology
- epidemiology
- evolutionary biology
- exercise physiology
- genetics
- genetics related
- human ecology
- human/medical genetics
- immunology
- marine biology and biological oceanography
- medical microbiology and bacteriology
- microbiological sciences and immunology related
- microbiology
- molecular biochemistry
- molecular biology
- molecular biophysics
- molecular genetics
- molecular pharmacology
- molecular physiology
- molecular toxicology
- mycology
- neurobiology and neurophysiology
- nutritional sciences
- pathology/experimental pathology
- pharmacology
- pharmacology
- pharmacology and toxicology
- pharmacology and toxicology related
- physiology
- plant genetics
- plant molecular biology
- plant pathology / phytopathology
- plant physiology
- radiation biology
- reproductive biology
- sociobiology
- toxicology
- wildlife biology
- zoology/animal biology
- zoology/animal biology related

Specialty Areas

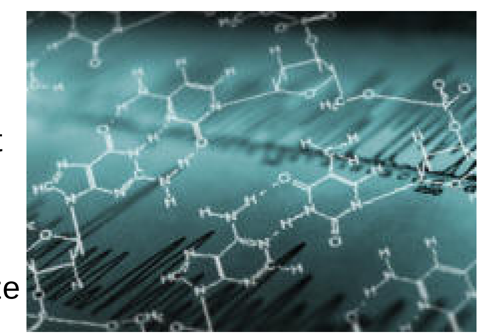
Most biological scientists are further classified by areas of focus. The following is a list of several major specialty areas within the biological sciences:

- Biochemistry
- Bioinformatics and Biostatistics
- Biophysics
- Cell and Molecular Biology
- Ecology/Environmental Science
- Genetics
- Immunology
- Marine and Aquatic Biology
- Microbiology
- Neuroscience
- Nutrition and Food Science
- Pharmacology
- Physiology

Biochemistry

Biochemistry is the "Chemistry of Life," the study of the chemistry of living cells, tissues, organs, and organisms. It seeks an understanding of every aspect of the structure and function of living things at the molecular level, including, for example, how enzymes, hormones, and genes work and how organisms get energy. Biochemists work with all types of biological organisms, including animals, plants, and microorganisms. Biochemistry is closely linked to various other biological sciences, such as Cell Biology, Genetics, Microbiology, Molecular Biology, Physiology, Pharmacology, and Toxicology. In fact, in many cases the distinctions between these disciplines are becoming increasingly blurred. Biochemists, working with colleagues in other disciplines, have discovered how to produce, through cloning techniques, therapeutically important proteins such as human insulin and blood clotting factors. Biochemists also developed DNA fingerprinting, which is used in forensic science and in the diagnosis of inherited disease. (Source: adapted from The Biochemical Society)

Bioinformatics and Biostatistics

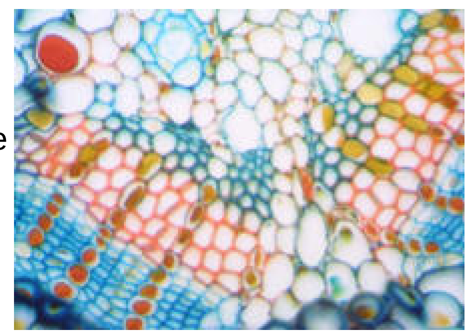


Bioinformatics, sometimes called Computational Biology, is the use of techniques from applied mathematics, informatics, statistics, and computer science to solve biological problems. Sequencing the human genome was a great accomplishment by geneticists, but the task of understanding the sequences and patterns of millions of building blocks requires new approaches that the field of Bioinformatics is developing. These scientists develop new tools to help search and analyze huge databases, such as the human genome or protein structures. They also create models and derive predictions to help understand the complex mechanisms of life process in an array of organisms. Biostatistics and Biometrics are fields that use statistical methods and mathematics to better understand biology. These scientists formulate models to describe (and explain) underlying mechanisms of fundamental life processes, whether behavior in a population or molecular properties. They also interpret data across a wide range of fields, including agriculture, biology, and medicine. Clinical biostatisticians are concerned with the design and interpretation of clinical research, including clinical trials, ensuring that the results are significant and seeking early indicators of efficacy or unanticipated adverse effects. (Source: adapted from the Blueprint Initiative and ASA Biometrics Section)

▶ Biophysics

Biophysics is that branch of knowledge that applies the principles of physics and chemistry and the methods of mathematical analysis and computer modeling to understand how biological systems work. Biophysics is a molecular science. It seeks to explain biological function in terms of the properties of specific molecule and the larger structures into which these molecules assemble (such as chromosomes and membranes). Sometimes this involves designing and building new laboratory instruments. Research in Biophysics addresses fundamental questions such as how cell membranes selectively transport water-soluble molecules across the lipid structure or how a muscle cell converts the chemical energy of ATP into mechanical force and movement or how sound waves are detected by the ear and converted into electrical impulses that provide the brain with information about the external world. Some of the research addresses questions relevant to medicine, such as the mechanisms of action of cancer drugs or methods for measuring glucose concentration in the blood of diabetics. (Source: adapted from the Biophysical Society)

▶ Cell and Molecular Biology



Cell Biology is the study of the structure and function of cells, how they grow, divide, and die, how they develop into larger clusters with unique properties, how they send signals to one another, and how all of these processes may go awry to cause diseases such as cancer. Molecular Biology is closely tied to Cell Biology, but focuses on research questions and techniques at the subcellular level. Molecular Biology has also become synonymous with a set of techniques to study biomolecules such as DNA, RNA, and proteins -- how the function of these molecules are regulated and coordinated. In other words, the study of how genes are turned "on" and "off" as needed, and how chemical or other changes in the molecules relate to subtle changes in their structure and function as an organism matures, encounters a new environment, or becomes ill. (Source: adapted from American Society for Biochemistry and Molecular Biology)

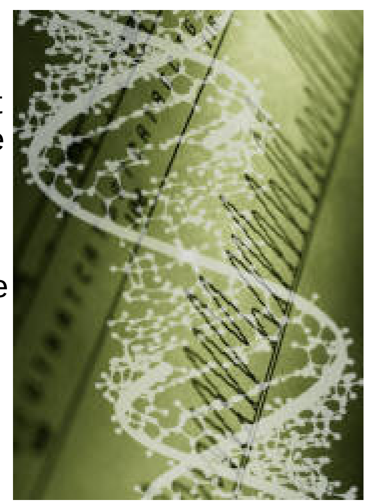
▶ Ecology/Environmental Science

Ecology is the study of where and how plants, animals, and microorganisms live and interact in the land, water, and air. This discipline is concerned with the relationships among organisms and their past, present, and future environments. The relationships include physiological responses of individuals, structure and dynamics of populations, interactions among species, organization of biological communities, and processing of energy and matter in ecosystems. Many scientists involved in conservation of natural resources and preserving endangered species are trained as ecologists. The study of specific environments may have a separate name, such as Marine Biology (the study of organisms living in oceans and seas). Some ecologists have a special interest in evolution and how specific plants or animals have adapted to changes in their environment (often over long periods of time). Others ecologists are interested in the more immediate impact of changes such as the introduction of species or chemicals that are not native to the environment. (Source: adapted from Ecological Society of America)

▶ Ecology/Environmental Science

Entomology is the study of insects and their relationships to the environment, humans, and other organisms. More than one million species of insects have been identified around the world. Some entomologists work in the outdoors (fields, forests, lakes, cities, etc.), others in laboratories and/or classrooms, and yet others work in offices, with regulatory or administrative responsibilities. Entomologists, in their study of insects, make contributions to a wide array of fields, including agriculture, health, and forensics. Some insects, for example, are agricultural pests while others are beneficial, indeed essential, to crops. TV programs have also made everyone aware of the study of insects in the analysis of some crime scenes. Insects also are vectors of disease, and studies with that orientation focus on insect life cycles, the development of control measures, and how insects become resistant to insecticides. (Source: adapted from the Entomological Society of America)

▶ Genetics



Each organism makes copies of the genes that it inherits from its parents and then transfers these copies to its offspring. Genetics is the study of how genetic information is communicated including: what genes are, how they are duplicated and transferred, how they change in individuals by mutation and in populations by selection during evolution, how they are expressed to produce cells and organisms, and how they can be manipulated to improve agriculture and cure genetic diseases. The consideration of genetic questions has become a component of virtually every area of biology, allowing scientists to design experiments that help them understand normal life processes and what happens when these processes are disrupted by disease. The impact of genetic information on medicine is rapidly increasing, as is the role of genetic counselors, who help patients understand their own risk of disease and/or the risk of passing a genetically based disease to their children. Genetic engineering is a field that works toward treating (or preventing) disease by replacing faulty genes. (Adapted from Genetics Society of America)

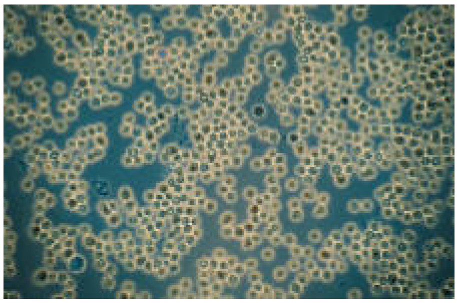
Immunology

Immunology is the study of all aspects of the immune system, the system responsible for protecting organisms from foreign invaders. In humans, the immune system is involved in mediating allergic responses, fighting infectious disease, rejecting transplanted tissues and organs, and autoimmune disorders (such as multiple sclerosis) in which the body "attacks" itself. Immunologists are interested in the cells that make up the immune system and how they interact and function including: their influence on other systems of the body; malfunctions of the immune system in immunological disorders (autoimmune diseases, hypersensitivities, immune deficiency, graft rejection); and the physical, chemical, and physiological characteristics of the components of the immune system. This knowledge is used to develop new drugs and vaccines. Immunology also is important to solving public health challenges such the emergence of drug resistant strains of bacteria and viruses or understanding changes that allow infectious microbes to "jump" from animals to humans. (Source: adapted from Wikipedia and The American Association of Immunologists)

Marine and Aquatic Biology

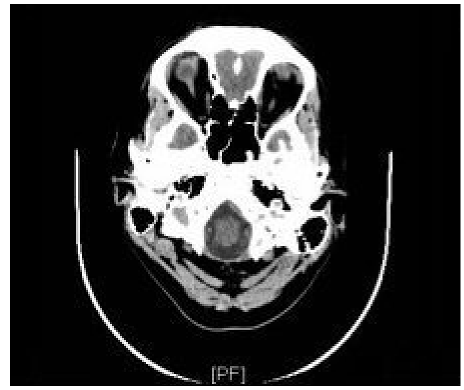
Marine Biology is the study of animals, plants, and microorganisms that live in or near a salt water environment. Aquatic Biology, a broader term, includes not only marine studies, but also Limnology, the study of fresh water organisms. These scientists are interested in the marine and freshwater organisms' growth and development, their behavior, including communication among themselves, and their interactions with their environment. Some of these biologists study a particular organism, while others study many organisms in a particular region, climate, or ecological niche. The studies overlap with all of biology: ecology, genetics, neuroscience, and physiology, to name just a few of the fields included in Marine Biology and Limnology. Some of the concerns of the field are basic research, understanding the world of marine and fresh water environments. Other concerns are more practical, such as how to deal with organisms that foul power plant intake pipes or surfaces of ships, improving the yield and commercial quality of aquaculture, or the impact of ship sonar on communication among marine mammals. (Source: adapted from MarineCareers.net)

Microbiology



Microbiology is the study of the world of organisms too small to be seen with the naked eye. Microbes include viruses, bacteria, molds, protozoans, and other tiny creatures. Microbes cause disease, ferment alcoholic beverages, influence the quality and taste of our food, and are responsible for decay in nature. Microbiologists study how these organisms grow and reproduce and how they adapt to their environment. Some scientists specialize in the study of microorganisms growing in exotic environments, such as hot springs, hydrothermic vents in the ocean, or glaciers. Other microbiologists are closely allied to medicine, studying, for example, how bacteria cause disease and how they become resistant to antibiotics. Genetics and biochemistry are very important tools for microbiology, and vice versa. The extensive characterization and rapid growth of microbes has allowed them to be used as experimental tools in other branches of biology. For example, the modern study of how genes work depended on pioneering studies of gene function in viruses and bacteria. (Source: adapted from American Society for Microbiology)

Neuroscience

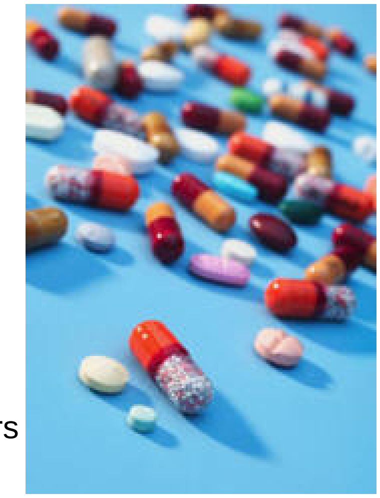


Neuroscience is the study of how cells in the brain and nervous system develop and function, both on an individual level and, even more importantly, as integrated systems of cellular networks. The field of Neuroscience covers everything from molecules, genes, and proteins to behavior. It includes the study of brain development, sensation and perception, learning and memory, movement, sleep, stress, aging, and neurological and psychiatric disorders. Some neuroscientists study the whole organism (behavior), others study specific kinds of cells in the brain, and yet others use computers as their “model system.” Some study “simple” systems, such as fruit flies and tiny worms, because so much is known about the genes that control their behavior, while other neuroscientists are delving into the much more daunting study of humans. As with other disciplines of biology, some neuroscientists are interested in basic understanding of how the system works, while others are studying ways to prevent or cure nervous-system based disorders. (Source: adapted from Society for Neuroscience)

Nutrition and Food Science

Nutrition is the study of all aspects of the relation of diet to health and disease, especially in humans and animals of agricultural or zoological importance. Such studies includes determining nutritional requirements and how they change over the life cycle or during the course of disease, nutritional risk factors for disease (either over- or under-supply), eating disorders and weight management, dietary supplements, and special considerations for sports. Food Science is concerned with all aspects of food, including its nutritional content, additives and contaminants, and packaging as well as the security of our food supply. Food scientists study the physical, microbiological, and chemical content of food, as well as the interaction of food components with each other, with air, and with packaging materials, and the preservation of quality during processing, transport, and storage. Both Nutrition and Food Science are closely related to the fields of biochemistry, pharmacology, and physiology. (Source: adapted from American Society for Nutritional Sciences and from Institute of Food Science and Nutrition)

Pharmacology



Pharmacology is the study of chemicals (drugs) that affect the function of living organisms, whether the chemical is intended to be therapeutic or is an abused substance. Clinical pharmacologists study chemicals of medicinal interest—how they are absorbed, transported, and metabolized in the body, how they function therapeutically, how to change their chemical structure so as to minimize unwanted side-effects. Some pharmacologists purify substances derived from nature (for example, plant materials) in search of new drugs, while others use knowledge of the molecular mechanisms of disease to “design” therapeutic drugs that they synthesize in the laboratory. Pharmacology can also be the study of the body’s own internal chemistry, for example, chemical messengers such as hormones and transmitters, and how these are produced, packaged, and transported in the body’s normal functioning. Modern pharmacology also is closely tied to biotechnology. (Source: adapted from British Pharmacological Society)

Physiology

Physiology is the study of how the body works, focusing on the function of cells and tissues in organ systems and how they are coordinated for the entire body, under normal circumstances and when exposed to stresses. Physiologists study life processes from the molecule to the whole organism. For animals, the systems studied include cardiovascular, digestive, excretory, immune, musculoskeletal, nervous, and reproductive, and how hormones coordinate the functions of all of these. Physiologists ask how these systems work under normal conditions and with disease or under stress. How do they keep us warm in cold environments and cold in hot environments, how do we adjust to low oxygen at high altitudes, how do our heart and lungs adapt to intense exercise, and what happens to astronauts when weightless for extended periods? Plant physiologists study comparable questions, focusing, for example on photosynthesis and nutrient and water transport. (Source: adapted from American Physiological Society)

Day in the Life

Biologists study living organisms: how they grow, reproduce, and interact among themselves and with their environment. Most work in some kind of research. Regardless of the area of specialization, in modern biology full understanding of a process requires integrating studies at many levels of organization: populations, individual organisms, organ systems, cells, and molecules. Accordingly, the day-to-day activities involve a variety of activities.

As for any experimental science, the Ph.D. Biologist must spend time deciding on the question to be addressed, designing a series of experiments, gathering the test materials, conducting the experiments, collecting and analyzing the data, organizing the results for presentation to other scientists (in meetings with colleagues, in papers published in scientific journals, or in talks presented at scientific conferences), and then thinking of the next series of questions raised by the experimental results. In addition, the Biologist must spend time reading the scientific literature, attending conferences, and talking with colleagues to stay current in their field of research, learning of new findings, new theories, and new technologies.

Those working in government or industry often have to prepare justifications for their working budgets. Those in academia usually have to prepare grant proposals in order to receive funding for their research. Professors must also spend time preparing lectures for students. All research scientists who direct a laboratory must also supervise their staff. While the activities noted above are common to almost all biologists in a general way, the details may be unique to the specialty area. Depending on the organism being studied, a Biologist may need to grow it in the laboratory (bacteria, viruses, algae, mice, fish, etc.), observe it in its own habitat (mountains, meadows, forests, deserts, oceans, streams, or the air, for example), or collect wild specimens to study in the laboratory. The laboratory instruments used may be microscopes or special equipment for observing electrical events, spectroscopic signals, or other chemical or physical properties. If dealing with dangerous infectious or toxic agents, then the Biologist must work in special environments that protect the scientist, the environment, and the public from contamination. Bachelor’s and master’s level Biologists do much the same as the Ph.D.s, although they usually are not responsible for obtaining grant funding or professional presentations at scientific meetings. Most Biologists also engage in some type of "service" activities -- serving on committees in their workplace or for their professional society, for example, or participating in outreach activities, explaining their work to the adult public or school children.

▶ The Workplace

Working hours for Biologists very much depend on the nature of their work. The work in a laboratory may be very regular, but sometimes the demands of an experiment go beyond a 9-5 day and the entire effort would be ruined if stopped abruptly at the normal end of the workday. While out in the field observing or collecting specimens, a Biologist must follow the habits of the creature under study -- if it is nocturnal, for example, the day may be 9-5, but that is 9 PM to 5 AM!

The laboratory environment may be busy, with lots of coworkers and noisy experimental subjects, or very quiet, with just one or two researchers. The laboratory may be in a building on an academic campus, part of a complex of industrial buildings, located in a hospital, or tucked into a corner of a marine biology research vessel. Biologists who work in the field have even more varied workplaces: as different as the habitats in the world around us. The scientist may be climbing a mountain, boating on a lake, tromping through a rain forest, or diving at a coral reef. If a field station serves as headquarters for the project, the facilities may be primitive (no hot water, for example) or have all the amenities (including the latest sophisticated equipment). For Biologists who work in an office, as an administrator, analyst, or regulator, the work hours tend to be regular. Even in such jobs, however, impending deadlines may require extra hours from time to time.

Earnings

Because the career paths open to those with a degree in the biological sciences are so diverse, potential salaries also vary widely. The figures below show the most recent average annual earnings for biologists in fields monitored by the U.S. government. The table below includes data from the National Occupational Employment and Wages Estimates Report and shows mean average annual earnings. Salaries can vary considerably within a field, and the range varies across different fields.

Field Average	Mean Annual Earnings
Biochemistry & Biophysics	$80,900
Conservation	$55,410
Microbiology	$65,200
Biological Scientists	$63,560
Zoologists and Wildlife Biology	$56,120
Other Life Sciences	$64,480

The table below shows the variation in average annual earnings in different employment sectors, using the field of Biochemistry and Biophysics as an example.

Industry Average	Annual Earnings
Colleges and universities	$48,660
State government	$48,940
General medical and surgical hospitals	$80,330
Pharmaceutical and medicine manufacturing	$90,920
Scientific research and development services	$84,080

According to the National Association of Colleges and Employers, beginning salary offers in 2007 averaged $34,953 a year for bachelor's degree recipients in biological and life sciences. In the Federal Government in 2007, general biological scientists earned an average salary of $72,146; microbiologists, $87,206; ecologists, $76,511; physiologists, $100,745; geneticists, $91,470; zoologists, $110,456; and botanists, $67,218. The table below shows the average salary for Biologists working for the U.S. Federal Government in 2007.

Field Average	Annual Salary
Botany	$67,218
Ecology	$76,511
Microbiology	$87,206
Genetics	$91,470
Physiology	$100,745
Zoology	$110,456

According to the latest data (2007) from the American Federation of Teachers, the average teacher salary was $47,602. For those just starting in the teaching profession, the 2004-05 school year was $31,753, up 3.1 percent from the year before. Science teachers are currently in high demand throughout the U.S.

Employment

Biologists hold about 87,000 jobs in the U.S. About 39 percent of all biological scientists were employed by Federal, State, and local governments. Federal biological scientists worked mainly for the U.S. Departments of Agriculture, Interior, and Defense and for the National Institutes of Health. Most of the rest worked in scientific research and testing laboratories, the pharmaceutical and medicine manufacturing industry, or colleges and universities. The following is a partial list of employers of Biologists:

Pharmaceutical and Biotechnology Companies

- Abbott Laboratories
- Amgen Inc.
- Bristol-Myers Squibb Company
- Genentech
- GlaxoSmithKline
- Hoffmann-La Roche Inc.
- Johnson & Johnson
- Merck & Company
- Procter & Gamble Company
- Wyeth Pharmaceuticals

Hospitals and Medical Centers

- Childrens Hospital Los Angeles
- Cleveland Clinic Foundation
- Massachusetts General Hospital
- MD Andersen Cancer Center
- Members of Association of Academic Health Centers

U.S. Federal Government

- Department of Agriculture
- Department of the Interior
- Department of Defense
- Environmental Protection Agency
- NASA
- National Institutes of Health
- Walter Reed Army Medical Center

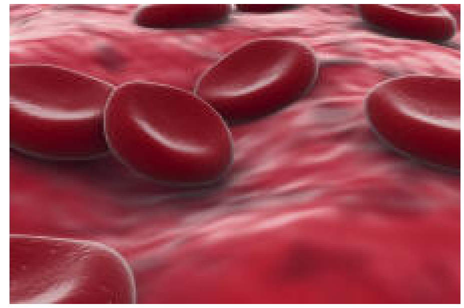
Educational Institutions

- Aquaria
- Botanical Gardens
- Colleges and Universities
- K-12 Schools
- Museums
- Zoos

Professional Associations

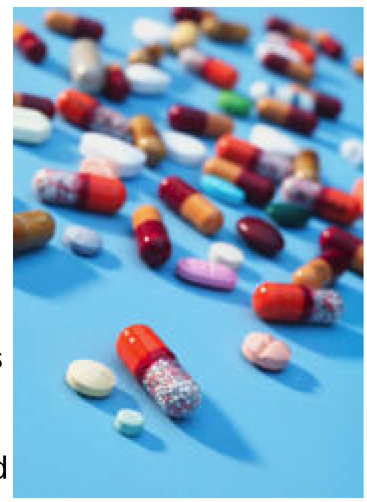
- Professional Associations Serving Biologists (see last page)
- Professional Associations Serving Women and Minority Groups

Career Path Forecast



According to the U.S. Department of Labor, Bureau of Labor Statistics, biological scientists can expect to face competition for jobs. After a recent period of rapid expansion in research funding, moderate growth in research grants should drive average employment growth over the next decade. Employment of biological scientists is projected to grow 9 percent over the 2006-16 decade, about as fast as the average for all occupations, as biotechnological research and development continues to drive job growth.

The Federal Government funds much basic research and development, including many areas of medical research that relate to biological science. Recent budget increases at the National Institutes of Health have led to large increases in Federal basic research and development expenditures, with research grants growing both in number and dollar amount. Nevertheless, the increase in expenditures has slowed substantially and is not expected to match its past growth over the 2006-16 projection period. This may result in a highly competitive environment for winning and renewing research grants.



Biological scientists enjoyed very rapid employment gains since the 1980s -- reflecting, in part, the growth of biotechnology companies. Employment growth should slow somewhat, as fewer new biotechnology firms are founded and existing firms merge or are absorbed by larger biotechnology or pharmaceutical firms. Some companies may conduct a portion of their research and development in other lower-wage countries, further limiting employment growth. However, much of the basic biological research done in recent years has resulted in new knowledge, including the isolation and identification of genes. Biological scientists will be needed to take this knowledge to the next stage, which is the understanding how certain genes function within an entire organism, so that medical treatments can be developed to treat various diseases. Even pharmaceutical and other firms not solely engaged in biotechnology use biotechnology techniques extensively, spurring employment increases for biological scientists. For example, biological scientists are continuing to help farmers increase crop yields by pinpointing genes that can help crops such as wheat grow worldwide in areas that currently are hostile to the crop. Continued work on chronic diseases should also lead to growing demand for biological scientists. In addition, efforts to discover new and improved ways to clean up and preserve the environment will continue to add to job growth. More biological scientists will be needed to determine the environmental impact of industry and government actions and to prevent or correct environmental problems such as the negative effects of pesticide use. Some biological scientists will find opportunities in environmental regulatory agencies, while others will use their expertise to advise lawmakers on legislation to save environmentally sensitive areas. New industrial applications of biotechnology, such as new methods for making ethanol for transportation fuel, also will spur demand for biological scientists.

There will continue to be demand for biological scientists specializing in botany, zoology, and marine biology, but opportunities will be limited because of the small size of these fields. Marine biology, despite its attractiveness as a career, is a very small specialty within biological science.

Doctoral degree holders are expected to face competition for basic research positions. Furthermore, should the number of advanced degrees awarded continue to grow, applicants for research grants are likely to face even more competition. Currently, about 1 in 4 grant proposals are approved for long-term research projects. In addition, applied research positions in private industry may become more difficult to obtain if increasing numbers of scientists seek jobs in private industry because of the competitive job market for independent research positions in universities and for college and university faculty.
Prospective marine biology students should be aware that those who would like to enter this specialty far outnumber the very few openings that occur each year for the type of glamorous research jobs that many would like to obtain. Almost all marine biologists who do basic research have a Ph.D.

People with bachelor's and master's degrees are expected to have more opportunities in nonscientist jobs related to biology. The number of science-related jobs in sales, marketing, and research management is expected to exceed the number of independent research positions. Non-Ph.D.s also may fill positions as science or engineering technicians or as medical health technologists and technicians. Some become high school biology teachers.

Biological scientists are less likely to lose their jobs during recessions than are those in many other occupations because many are employed on long-term research projects. However, an economic downturn could influence the amount of money allocated to new research and development efforts, particularly in areas of risky or innovative research. An economic downturn also could limit the possibility of extension or renewal of existing projects.

Professional Organizations

Professional organizations and associations provide a wide range of resources for planning and navigating a career in Biology. These groups can play a key role in your development and keep you abreast of what is happening in your area of specialization. Most maintain a website and many of the associations have special pages for high school and/or college students with questions about careers in the field. Associations promote the interests of their members and provide a network of contacts that can help you find jobs and move your career forward. They can offer a variety of services including job referral services, continuing education courses, insurance, travel benefits, periodicals, and meeting and conference opportunities. Some of these organizations have special interest in issues related to women or underrepresented minority groups.

The following is a partial list of professional associations serving biologists:

- American Association of Immunologists (www.aai.org)
- American Society of Limnology and Oceanography (www.aslo.org)
- American Association of Pharmaceutical Scientists (www.aapspharmaceutica.com)
- American Physiological Society (www.the-aps.org)
- American Society for Biochemistry and Molecular Biology (www.asbmb.org)
- American Society for Cell Biology (www.ascb.org)
- American Society for Clinical Nutrition (/www.ascn.org)
- American Society for Nutritional Sciences (www.asns.org)
- American Society for Microbiology (www.asm.org)
- American Society of Exercise Physiologists (www.asep.org)
- American Society of Human Genetics (www.ashg.org)
- American Society of Plant Biologists (www.aspb.org)
- American Statistical Association, Biometrics Section (www.amstat.org/Biometrics)
- American Zoo and Aquarium Association (www.aza.org)
- Association of Neuroscience Departments and Programs (www.andp.org)
- Association of Science - Technology Centers (www.astc.org)
- Association of Zoological Horticulture (www.azh.org)
- Biophysical Society (www.biophysics.org)
- British Ecological Society (www.britishecologicalsociety.org)
- British Pharmacological Society (www.bps.ac.uk)
- British Society for Immunology (http://immunology.org/)
- Canadian Federation of Biological Societies (www.cfbs.org)
- Clinical Immunology Society (www.clinimmsoc.org)
- Ecological Society of America (www.esa.org)
- Entomological Foundation (www.entfdn.org)
- Entomological Society of America (www.entsoc.org)
- European Biophysical Societies Association (www.ebsa.org)
- Genetics Society of America (www.genetics-gsa.org)
- IEEE - Computational Intelligence Society, Bioinformatics and Bioengineering Technical Committee (www.ieee-cis.org)
- Institute of Food Science and Nutrition (/www.ilw.agrl.ethz.ch)
- Institute of Food Science and Technology (www.ifst.org)
- Institute of Food Technologists (www.ift.org/cms)
- International Federation of Human Genetics Societies (www.ifhgs.org)
- International Society for Clinical Biostatistics (www.iscb.info)
- International Society for Computational Biology (www.iscb.org)
- International Union of Biochemistry and Molecular Biology (www.iubmb.org)
- International Union of Food Science & Technology (www.iufost.org)
- MidSouth Computational Biology & Bioinformatics Society (www.mcbios.org)
- Pharmaceutical Research and Manufacturers of America (www.phrma.org)
- Society for Neuroscience (http://web.sfn.org/)
- Society of Cell Biology (www.kcl.ac.uk/kis/schools/life_sciences/biomed/bscb/top.html)
- The Biochemical Society (www.biochemistry.org)
- The Society of Rheology (www.rheology.org)
- Waksman Foundation for Microbiology (www.waksmanfoundation.org)

The following is a partial list of special focus professional associations serving women and minorities:

- American Indian Science and Engineering Society (www.aises.org)
- American Physical Society - Committee on the Status of Women in Physics (www.aps.org/educ/cswp)
- Association for Women in Science (www.awis.org)
- National Society of Black Engineers (www.nsbe.org)
- National Society of Black Physicists (www.nsbp.org)
- National Society of Hispanic Physicists (http://utopia.utb.edu/nshp)
- Society for the Advancement of Chicanos and Native Americans in Science (www.sacnas.org)
- Society of Hispanic Professional Engineers (www.shpe.org)
- Society of Mexican American Engineers and Scientists (www.maes-natl.org)
- Society of Women Engineers (www.swe.org)
- Vietnamese Association for Computing, Engineering Technology, and Science (www.vacets.org)